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INDUSTRIAL MANAGEMENT

INDUSTRIAL MANAGEMENT

BY

RICHARD H. LANSBURGH

PROFESSOR OF INDUSTRY
UNIVERSITY OF PENNSYLVANIA

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PREFACE

With the confident judgment that in careful analysis of management problems is to be found the hope of industry, this book has been developed. Stress has been placed on general organization problems, not only in the chapters on organization, but throughout the text, with the deep conviction that if a satisfactory structure be developed for any enterprise, all other phases of management are simplified.

With the hope of stressing the fundamentals of sound management, which must be developed prior to granting attention to more spectacular phases, a number of chapters have been devoted to the background of present-day management policies, to organization as an abstract consideration, and to often-unappreciated standardization work. Throughout, the effort has been made to show the relationships of each major portion of the business to the other and the interdependence of the various major departments. Policies and principles of successful management form the background, into which are fitted the devices to carry them into effect, without which no management, however highly conceived, may be successful.

Operations have been treated with the belief that faith must be created in modern business, faith of the management in the employee, and faith of the employee in the management. They have been described with the thought that worthwhile management must be courageous, must be willing to lead, but must be always careful lest unprofitable experiments discourage future attempts to improve management methods.

The examples and illustrations have been chosen from a diverse group of industries in the hope of insuring that good management be looked upon as universally applicable. At the same time they have been chosen from the standpoint of best explaining the problem at hand. Illustrations have been taken from particular plants, wherever practicable; but necessarily, for clarity and to reach fundamentals, applications have at times been made to insure full understanding of the general principles. In the main, the text has been developed from the point of view of the medium-sized plant, but frequent reference has been made to the large and the small enterprise. Such basic principles and policies as have been laid

down are applicable everywhere, and only the systems and devices which carry them into effect must be modified as the size of the plant changes.

In brief, this book aims to present a co-ordinated, simple treatment of the problems, the ideals, and the methods of successful industrial management in a way which is at the same time broad and specific, and which aims to indicate the responsibilities of the factory executives to the workers, the stockholders, and the community.

During the preparation of this book, over a period of several years, the constant help and advice of numerous industrial executives has made possible the presentation of much of the material which is included. The author wishes to express especial appreciation of the aid received from Mr. Percy S. Brown, Works Manager of the Corona Typewriter Company; Mr. George Comfort, Works Manager of the Miller Lock Company; Mr. James M. Ketch of the National Lamp Works; and Mr. H. K. Hathaway, Consulting Engineer in Management. Mr. Charles B. Gordy, Assistant Professor of Mechanical Engineering, University of Michigan, and Mr. John S. Keir, Professor of Industrial Economics, Carnegie Institute of Technology, have also rendered criticisms and comments which have materially assisted in developing the text. During the preparation of the book continual constructive comment and criticism, and, indeed suggestions for rearrangement of material, as well as much of the material itself, have been received from the following, who are or have been instructors in the Department of Industry of the Wharton School of Finance and Commerce of the University of Pennsylvania: Messrs. Robert P. Brecht, John W. Carter, Leon Henderson, Victor S. Karabasz, Francis P. O'Hara, Norris M. Perris, Theodore R. Snyder, and Morton S. Whitehill. For reading the completed manuscript and making numerous valuable comments thereon, the author is very grateful to Professor Erwin H. Schell, of the Massachusetts Institute of Technology. He wishes to express his deep appreciation of the aid received from all these sources, to which such features of this text as may be valuable are largely due.

RICHARD H. LANSBURGH.

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INDUSTRIAL MANAGEMENT

PART I

INTRODUCTION

CHAPTER I

MANAGEMENT AS A BUSINESS FACTOR

MANAGEMENT, the unseen force which drives all that is physical within a factory, is by far the greatest factor of the present industrial age. Machinery and materials may be put to work, workers may labor; but without adequate management to guide their operations into profitable channels, to distribute the results of their work effectively, and to govern their operations during performance, this performance may become so uneconomic as to cease entirely.

We are accustomed to think of the physical thing, the huge plant, the wonderful machine, the great railroad terminal, the mammoth locomotive. We may instinctively realize that some human force must have been called upon to create them, to bring them into being. But the methods of creating this force, of exercising its potentialities, are little thought of, even by those who come into daily contact with it. Most of us, particularly if we have lived some years in a large manufacturing center, see so much of the physical side of industry that we do not think primarily of the directing force, but of the result. We begin to regard enormous manufacturing plants, with their thousands of workers fashioning the product by combined, directed effort, as one of the commonplaces of life. Seldom do we stop to consider how these great plants came into being, how and by whom they were organized, or the effect of their presence and policies upon the life of the community. We merely accept them as we find them.

Only as a great strike interrupts the flow of commerce, or a great

depression stagnates it and causes the machinery in the plant to stop, the windows to be dark at night, and front-page headlines to appear in the newspapers, do most of us stop and ask, "Is not something wrong?" Too large a number of plant executives have had the same tendencies. Perhaps the ever-pressing problems of the present have not allowed time for retrospection or for policy-planning; perhaps they have been lulled into satisfaction by cumulative results of a period of prosperity that, instead of their own directive efforts, has acted as the hidden management force for their physical plant. Whatever may be the cause, strikes, unemployment, the cancers of industrial peace and prosperity, have frequently been given all the attention, and modest ailments and preventive medicine have passed unnoticed.

Articles in newspapers and magazines have lately been making all of us aware that there does exist some hidden force that controls industrial plant operation. With this aroused consciousness has come the dawn of a new industrial day, in which the method of management, rather than the nature of the machinery, is the basis of the estimate of a plant's value to the community. A new concept of the industrial community is coming into being; and although it is very nebulous as yet, and although we are in the midst of a period of transition wherein various factors in our industrial life seem to be irredeemably aligned against one another; nevertheless executives have come to talk management, periodicals have come to talk management, and the general public is beginning to realize that in the force of management lies the path to better understanding of industrial problems and through that to better community life. The test of the present industrial system is its ability to adjust itself to modern conditions. Management will largely determine whether or not it will meet that test.

Progressive establishments have for years been dealing with management as a separate business factor. They have realized the difference between drift and control in the operation of a business, and some of the outstanding business successes of the last two decades are tributes to the intelligent study of the hidden governing force of business. Gradually the gospel of careful thought in management has been spreading. Competition in methods of distribution, and carefully analyzed selling methods have made many concerns stop and look beyond the methods of the moment which they have been using. Hundreds of plants have been obliged to abandon the policy of drift by the cheaper production costs and the better working forces of their competitors. Carefully analyzed action has been substituted for the older methods of operation, and has automatically brought better management with it.

The extent of management, within several businesses, is found to vary greatly. In past years, it has been difficult for the observer, however

closely he may have looked, to see that management has been a very great factor in some plants. The physical structure has seemed to run itself. Even if a few units within an industry have focused their attention on management matters, competition within that industry has frequently not been such as to compel other units to grant much attention to management problems in order to survive, or even to make steady progress. Whole industries have pursued a policy of drift to the extent that they have been most unstable. Individual plants within an industry, interested in looking for profits without providing for them, have become a source of financial worry, not only to their owners, but to those financial institutions which have been granting them credits.

The financial institution and industrial management. The backbone of industrial economic organization to-day may be said to be the financial structure which allows plants to operate on borrowed capital while turning their purchases of raw material and payrolls into the cash of the consuming public. For many years, the financial institutions engaged in granting credits to manufacturing establishments were accustomed to look primarily at the physical side of the plant. The balance sheet of the factory, as expressed in terms of machinery, plant and structures, raw material, finished product, and accounts owed or receivable, was the basis of extension of credit, subject, of course, to influences such as good-will or the individual reputation of the managing executives. This last factor was the closest approach which these financial institutions had made to an investigation of the type of management within a plant. Good management was presupposed, and yet poor management could waste the assets of the factory to such an extent that the figures on the balance sheet might become changed immensurably before the financial institution could clear itself.

Within recent years, banks have come to appreciate industrial management as a business factor. Though they still require the physical balance sheet to come up to certain marks of safety before advancing moneys for operation, those banks which have been giving factory business the most mature consideration have been going far beyond the physical balance sheet in estimating the worth of the plant. Many banks have specialists on their staffs, whose duty it is to survey the management policies of a concern as a supplement to balance-sheet information. Certain consulting companies make a specialty of evaluating the management of industrial plants for bankers. Associations of bank credit men are distributing to their members facts concerning the organization of specific industries and methods of management within those industries. Thus the credit man of the bank is enabled to determine some of the more intangible, hidden, but fundamental points of strength or weakness in the financial condition of the industrial enterprise.

What is management? We have spoken of management, and of its position in industry, but as yet have not defined it. Management is a broad term and covers almost all the non-physical factors in the operation of an enterprise. It involves all the elements in the control of business activities, and may be said to be the correlation of the details of operation of an enterprise so that it will work as a harmonious whole toward the desired goal. The goals of various enterprises may differ, as certainly the goal of a federation of charities would differ from the goal of a manufacturing establishment. In the main, the goal of all manufacturing enterprises is the same—profits in greatest possible amount to the owners of the business. However, this main goal is modified considerably from one business to another. One manufacturer will say that his goal is first and always profits; while another will say that, though it is true that he desires profits, yet he will not consider profits until his community of co-workers has a living wage. Another manufacturer may have a saving wage, rather than a living wage, as his prerequisite. On the other hand, programmes of operation which have these ideals as a basis assume that, over long periods, such programmes will lead to greater profits to the business than would programmes involving lower wages or less steady employment for the workers. The business which does not make a profit cannot long survive.

Business is organized for profit, and management methods which do not take this into account have proved of little value. Except in unusual circumstances, a manufacturing plant is not a laboratory for the trying out of certain management theories. Therefore, the first step that an executive takes in considering a management move is to ask, " Is it profitable?" or " Can it be made profitable? "

The general field of management is made up of three broad subdivisions: (1) the establishment of major policies, (2) the planning for, and setting up of, an organization to carry out these policies, (3) the operation of the enterprise through this organization. Reorganization work, which consumes so much of the attention given to management matters, consists of subdivisions of these three fields. As business conditions change, fundamental changes are needed in each of these fields. If a plant does not make the changes from time to time, as needed, it sometimes becomes necessary to engage in an extensive reorganization plan, which, because of its spectacular aspects, may come to be looked upon wrongly as the main field for management effort. The best-advertised management work has been reorganization, and this is largely because those who have panaceas for the ills of industry have been engaged in this work.

Management effort will call for the utilization of different types of genius, which are but seldom found in the same man. To establish policies and to plan for an effective organization requires mainly creative

ability, though this must be coupled with some ability to visualize methods of executing the plans that are devised. To operate a plant along the lines which have been laid down requires mainly executive ability. The manager who has this gift, together with the ability to create lines of plant development, is the effective manager of the first grade.

Our aim will be to study factory management that has been most effective, to understand fully the hidden power behind the physical plant, and to see how it may best be utilized. In order to fulfill our aim, three things will be necessary: (1) to determine the policies and principles of good management; (2) to see how they have been applied successfully; and (3) most important of all, to develop a scientific state of mind toward management problems. In order that we may more fully appreciate what management is, and the position that it holds in our economic life, it will be desirable first to review briefly some historical aspects of American industry and the growth of management as a business factor.

CHAPTER II

THE HISTORICAL BACKGROUND OF INDUSTRIAL MANAGEMENT

The realization that there is an industrial force, management, distinct from those of capital and labor, has come but slowly and recently into the consciousness of the industrial and the non-industrial public. That the growth of attention paid to management has been but recent is not surprising when the historical development of our present economic structure is considered. Moreover, a true evaluation of the importance of this comparatively new force in factory operation is dependent upon at least a brief consideration of American industrial history and development. Through a study of this, it will be easy to observe why factory executives have but begun to give mature consideration to management problems. The explanation is that the factory system itself is young. In its brief existence there have been many foundation stones to be laid before adequate attention might be directed to operating technique and management. The factory system is new, and consideration of management as an important factor in its operation is almost its newest phase.

The value of industrial history as an aid to industrial management. One of the most frequent causes of poor management and accompanying business ineffectiveness is the tendency to over-emphasize conditions which may exist at any given time. This frequently arises because an organization is so developed as to almost prohibit, from press of business on the part of the chief executives, both retrospection and policy-planning. Even a brief study of industrial history helps to prevent this glorification of the present and aids the executive to vision better the future policies of his enterprise. Every portion of industrial history will aid, from long before the beginning of our immediate industrial epoch to the ever-changing and all important present. Possibilities of guidance and understanding lie in the study of every period.

The significance of the fact that the relationships of capitalist, manager, executive, and worker, as we know them, in Europe or in America, are at most but slightly over a century old cannot be lost on him who studies industrial history. Yet within this century the structure of our new industrial society has been constantly changing and in a state of flux. Invention, the development of transportation and of education, have constantly increased human wants for manufactured products, and

increased the ability of the industrial world to satisfy these wants. Our society is dynamic, not static. Change is the fundamental characteristic of methods, both of technique and of management. What happened yesterday is of value in policy development, only in so far as it may aid us in determining what may happen to-morrow.

Milestones in industrial history. We frequently hear the factory system referred to as the fourth of the milestones in industrial history, the first three of which are domestic production, handicraft production, and cottage production. As a matter of fact, it will soon become evident that the factory period itself should be divided for consideration into several nearly distinct divisions. Domestic production was production in the household for the members thereof from raw materials furnished by the household itself. In its purest form, found at any time only for a temporary period and only on the very frontiers of civilization, the "domestic system" consists of the entire absence of exchange and the ability of each household to satisfy the wants of its members entirely by its own labor. The operations incident to carrying on the household and those incident to carrying on production are in this case practically the same, and the main activities are agricultural. Domestic production, the first system chronologically, still exists on a small scale to-day, in remote peasant communities where the wants of the people are simple and easily taken care of. However, there is no place to-day in the civilized or semi-civilized world where the wants of any household are entirely supplied by the domestic system; and, more and more, the variety of goods produced by even frontier peoples continues to decline, as improved transportation increases the opportunity of exchange.

The handicraft period. Handicraft production, the next milestone, was carried on either within or without the house and is characterized by what is termed "custom production." The handicraft worker usually worked for the consumer of his product, the region of the sale tended to be local, and the product of one craftsman might be bartered for the product of another, or an actual sale might take place.

Although the workers may still have owned a plot of ground and utilized this partially as a means of living, yet the handicraft worker was primarily a craftsman, a weaver, or a smith, for instance. The transition from domestic production to the handicraft system was gradual, and, in Europe, took place largely in the Middle Ages. The rise and growing economic importance of the mediaeval towns upon manor sites, or rather the growth of manors, due to the development of means of communication, usually by rivers or sea, aided materially in developing this new era in manufacture. A manorial village might not be able to support a specialist in manufacture, such as a shoemaker. The larger town, with its trade with the surrounding country, however, might well give a market of

sufficient size to enable its inhabitants to engage profitably in various phases of manufacturing as a profession.

Guilds. The development of the handicraft system was accompanied by the growth, during the twelfth century, of guilds or associations of workers in the same trade, banded together for mutual protection. These guilds marked a period of self-centered interest within the town. The vast majority of inhabitants of the town had but little reason to look beyond its borders or to come frequently into contact with the world outside. The prosperity of their town was their chief, and practically their only, concern.

Although the guilds were, in their inception, private societies, they soon became an important part of the town government and were granted the trade monopolies that were counted on to bring commercial success to the town. In many places, during the fifteenth century, the head of a particular guild would be recognized as the head of the municipality, though in other places the guilds were subject to the control of town authorities. The manufacturer of to-day, who feels that the trade union, as at present constituted, represents the first attempt of workmen to band together for their mutual benefit and to "dictate" the terms of production in the industry, should familiarize himself with the guild system. These guilds, being especially protected by the towns, had practically a monopoly of labor. No one could work at a craft without admission to the guild, and the limitations were severe. An apprenticeship of many years was usually necessary before a worker could establish a business for himself. There was no large class of wage workers under the guild system, but each worker, having passed through his years of apprenticeship, could become a master of the craft. There was no employer or employee class. While a man might be working as a journeyman there was no gulf between him and his employer. They worked in the same shop, side by side.

While the guild system was the chief organization feature of the handicraft period, it can readily be understood that in many towns where there was sufficient demand for the work of a craftsman in a particular trade there was not sufficient demand to have a body of men who could form a guild in that trade. Thus, weavers and smiths who were not members of guilds would be found throughout the country. They, however, had the same economic position as the guild worker, dealing directly with their customers.

The guilds and the present-day trade unions have much in common. Both desire to maintain a high standard of living among workers, and secure fair remuneration to this end, and both believe combined action a necessity in insuring this. Nevertheless, they are fundamentally different in many respects. In the guilds were to be found artisans only, no common workmen; members were all from one locality or town; composed of the

masters and middlemen, if any, in the trade, as well as the workers. The guild showed particular care for the customer, in such matters as quality. On the other hand, there were some journeyman guilds, composed of workers only, which bear some resemblance to present trade unions. These, however, never came to be much of a factor in the economic life of the handicraft period.

The cottage period. The control of the guilds over production did not survive to the opening of the factory era, though, in a larger sense, handicraft production did. The gradual development of capital, the discoveries and explorations of the fifteenth and sixteenth centuries, and the consequent growth of trade all caused the power of the guilds to decay, partly because of their restrictive regulations, such as the strict limitations they placed on the number of apprentices. The necessities of increased production, due to broadened market, would brook no such interference, and the entrepreneur began to make his appearance in industry. The master worker or merchant who had accumulated some capital bought raw material and distributed it to workers in the country and on the outskirts of the town, later collecting and selling the finished product either directly to the consumers, or to merchants in the towns. In the sixteenth and seventeenth and the early part of the eighteenth century, this method prevailed in the manufacture of staple commodities and became the forerunner of the factory system. This plan caused the era to be called the " cottage period " of industry, since so much of the work was done in the cottages just outside of the towns. It was a logical development of the handicraft system, though its full development was not reached until about six centuries after the beginning of the handicraft epoch in European industry. The people worked in their own houses, usually alternating this work with agriculture. They still owned the tools of production and had a direct interest in the product being manufactured, but their contact with the consumers of their product, who were no longer limited to persons in their own vicinity, was made for them by the merchants.

The little manufacturing that was allowed to go on in the American Colonies prior to the Revolution may be thought of as being of the cottage type. Some of it was pure handicraft industry, though practically without guilds.

Under conditions such as these, it was but natural that there should arise a few instances where the workers were grouped together. Beginning with the sixteenth century, we find records of " factories " where handicraft workers could be brought together and perform their duties under one roof. It is said that in Germany prior to 1800, there were about twenty factories, each employing between one hundred and five hundred persons. However, factories were distinctly the exception, and they did

not represent any real change in methods of production or in the economic structure of industrial society. The workers were grouped largely for their own convenience, and, though there may have been some division of labor begun, they still owned their own tools and were handicraft workers in every sense.

As trade expanded and new worlds began to open up in the seventeenth and eighteenth centuries, it became more and more evident that industrial production by the handicraft method was inadequate to meet the market needs of the world. Wealth had begun to be concentrated in the hands of capitalists, but there was no instrumentality through which this capital could be so utilized as to materially increase production. Thus the industrial world was so situated economically that it might almost be said to be awaiting the inventions of the last half of the eighteenth century that resulted in the development of the factory system.

The birth of the factory system. The birth of the factory system is usually said to have occurred with the invention in England of four great machines for the textile industry, during the closing years of the eighteenth century. James Hargreaves' " spinning jenny," patented in 1770, but in use several years before, was the first machine to spin yarn. This was improved upon in 1771 by Richard Arkwright in the invention of what he called his " water frame." This spinning device was so called because it was run by water power, though when he installed it in the first cotton spinning mill in England it had been run by horse power. In 1779 Samuel Crompton constructed his " mule," so called because its construction embodied features of both previous inventions. This device increased the potential production of yarn beyond the ability of the weavers to make it into finished fabric. This was directly contrary to conditions prior to the invention of Hargreaves' jenny, when the use of a " fly-shuttle " (practically a hand device) had given weavers a capacity for work that could not be met by the spinners. By this time, however, the invention of textile machinery had secured a fair start and the need was met by the fourth great invention, that of Edmund Cartwright's " power loom " in 1785. All of these inventions served, within comparatively few years, to revolutionize the textile industry—that industry which, possibly more than any other, is closely interwoven with human wants and human progress—and place it on a machine basis. Although it was not until the invention of the steam engine by James Watt, and its adaptation to factory work in the closing years of the century, that the hampering limitations of the use of water power were broken away from, nevertheless, the real industrial revolution, the change toward the factory system, had begun.

Similar inventions or changes in method took place simultaneously or shortly thereafter in many lines of work, particularly in metal-cutting.

The slide-rest for accurately guiding cutting tools, the turret, and the combination of these two elements into the automatic lathe, by Christopher M. Spencer, of Connecticut, were the great epoch-making improvements in machine-tool construction, and these were all made at about this time.

Effects of the industrial revolution. The effect of the industrial revolution on such industries as were established in the United States was felt almost as quickly as in England, because once machines were set up, hand labor could not compete, if some means of fairly cheap transportation were at hand. Industry by industry, the revolution changed all former manufacturing methods and conditions. The first cotton factory of any importance in the United States was established in 1790, but no date for the industrial revolution can be given, as it is still going on. Its beginning, which rocked the very basis of industrial society, lay in those early inventions of the late eighteenth century. Yet as late as 1850, in the United States, some trades, such as shoemaking, had barely been touched by its influence, and the old conditions of master, journeyman, and apprentice still were characteristic of the industry. Such differences as there were in the effect in the United States and England lay in the fact that England was primarily an industrial country, whereas there was but little manufacturing in the United States. Therefore, the immediate effect on the social and economic life of the people was here less marked, though largely governed by the same influences.

It was the crowding together of many workers in a space meant originally for a few, in the early English factory towns, which frequently secured most attention among the economic developments following the industrial revolution. However, it is not the mere bringing together of large numbers of working people under one roof, with the attendant evils of overcrowding of factory towns, that is the outstanding feature of this early factory era. It is necessary to keep primarily in mind the economic position of the workman, to appreciate the full effect of the introduction of the factory system. Factories had already been erected prior to the "four great inventions," and if these machines had never been constructed there would probably have been an increasing tendency to centralize work in larger units, which might conceivably have resulted in most of the evils found in factory towns of the early nineteenth century. Neither is it the mere invention of machines with greatly increased production possibilities that constitutes, from our standpoint, the great significance of the industrial revolution. The real change is found in the new status of the worker in industry. This developed from the transfer of skill which was involved in the introduction of the factory system. Many of the conditions of modern factory organization, which are frequently traced back to the industrial revolution, are found as

effects of this transfer of skill. Included in these are the divorcing of the workers from direct interest in the final product and in the tools of production; also his loss of control over conditions of work, except as such conditions are limited by his critical survey after the employer has taken the initiative.

Prior to the industrial revolution it was the worker who had the skill; now the skill is largely to be found in the machines. Prior to this time all machines were used to aid the worker in performing his task; now the worker aids the machine. The significance of the transference of skill will perhaps be better understood if a concrete example be taken. To-day, in shoe factories, the shoe-hand who can make a complete shoe is the exception. All can make portions of shoes well, owing to the lodging of the traditional craft skill in such machines as the welt-machine and the pulling-over machine. The skill of the trade and the inventor has been transferred to the machines, and an operator with but little skill or training can be quickly taught to handle the machine and turn out the product. Similar effects are marked in the metal-cutting industries, where careful study of the many machines will indicate that transference of skill is far more important than division of labor as a factor in producing monotony, fatigue, and other phases of industrial working conditions which the modern manager must take into account.

Since transference of skill involves, at least temporarily, loss of earning power for the particular workmen involved, it is not hard to account for workmen frequently opposing the introduction of new machinery. The skilled worker found himself immediately and automatically degraded, in many cases, to the level of unskilled girls and boys, who could operate the new machines. This effect, it should be carefully observed, was not permanent in regard to the working-class as a whole. Large groups of workers were soon needed to produce the machines with which the others worked, and this, together with the general expansion of industry, afforded increasing employment for skilled men. Frequently, however, the individual suffered, as in the case of the skilled weaver, whose place was taken by the automatic loom, the skilled work on which was largely done by the metal worker, quite another man.

Opposition to the new machinery began with Hargreaves' invention, his first machine having been wrecked by a mob of spinners, and is still felt to-day in trades where the relative importance of the skill of the worker, as compared to that of the machine, is still high. An illustration of recent opposition is that occasioned by the introduction of the spraying machines in the painting trades. Opposition to the introduction of new devices may be directed toward those which increase output or absorb workers' skill *per se*. It may often be directed also, as lately discovered, toward devices or management methods which study or measure output with a view to

increasing it through bettering management's knowledge of how and how quickly work should be done.

The effects of the transference of skill were far-reaching and complex. One immediate effect, and one of the most significant, was to separate the worker from the ownership of the tools of industry. No longer was it possible for the apprentice, becoming a craftsman, to be presented by his proud mentor with the implements of his trade. Capital was now required both to build these new implements and to provide power to operate them. The rise of the capitalist class, already begun, was therefore necessarily accelerated. The immediate results, particularly in England, of the rapid rise of this newer class in society and the accompanying degradation of the worker are well known. The study of the sufferings of the English worker of the early nineteenth century should be carefully read by all who desire to express positive views on the relationship of capital and labor. Had it not been the day of the economic doctrine of "laissez-faire" and had not Britain been engaged in a long series of foreign wars, the industrial history of that period might have been different; but it now stands as the historic example of frightful working conditions—child labor to the point of death in childhood, and general inhuman treatment of the worker. It was but the natural result of too-rapid transition from one economic era to another.

The factory system in the United States. That the immediate results of the industrial revolution in the United States were socially less deplorable was due largely to the newness of the country, with its possibilities of agricultural settlement, and the fact that manufacturing industry was then relatively unimportant. Manufacturing in the United States began on a considerable scale during the first two decades of the ninteenth century, when the non-intercourse acts, the embargo, and the War of 1812 suppressed trade with European nations and largely forced us to do our own manufacturing. Our manufactures became established under the factory system, and this, together with the political structure of the country, explains why the social effect of the revolution was not so bad in the United States.

With the growth of urban communities, largely devoted to manufacturing, and with the rapid increase in immigration, there came later the need of factory legislation. The growth of the country made it impossible to rely any longer on alternative opportunity as the sole check on working conditions. With the opportunity for later action, and having the examples of Europe to guide us, this legislation, and in fact all controlling influences in American factory practice, have always been predicated on an "American standard" of living for factory workers. However poor this may have been in individual instances, it has at least been far superior to the general European level and has largely been responsible for

the difference between the courses taken by capital-labor relations in America and in European countries during the past few years. It is this "American standard," coupled with superior educational advantages, that has proved the greatest bulwark for our institutions where there have seemed to be dangers of undermining from without.

The factory system in the United States to-day bears no resemblance to that of 1850 and but little to that of 1880. To attempt to group all economic conditions that have existed since the industrial revolution under the one heading, "operation under the factory system," would be as much an error as to endeavor to group conditions under the handicraft era and the factory era together. It is impossible to divide the various periods in the development of American manufacturing industry by even as sharp lines as that dividing the period of cottage industry from the factory era, although we have seen that this itself was no distinct line. The development of economic institutions does not permit the setting of fine limiting period or date lines. Therefore, in dividing the factory system era in the United States into periods, no attempt will be made to give even approximate dates for the beginning and ending of the periods. In fact, the periods overlap, and, to some extent in some industries, we may even be in the first period at this time.

Three rather distinct periods may be discovered by a close analysis of industrial conditions: first, that in which the structure was started and the foundations laid; second, the period of great industrial expansion; and third, the period of attention to operating methods.

The beginnings of American industry. The first period is characterized by small factories, patterned basically along European lines, with relatively narrow markets and organizations dominated by the owner, or capitalist. The growth of a middleman organization and a financial organization to market the rapidly increasing product of the factories also is characteristic of this period. American manufacture had, as a basis for its early growth, the transplanting of European industry, almost bodily, to the shores of this country. European workmen, European machinery, frequently European superintendence and even European raw materials, formed the entire groundwork for the establishment of our early manufactures. The trends in the history of the early development of an industrial system for our industries and factories were only a repetition of the path of those same trends in Europe, particularly England, modified only to fit the American environment. This was a period when immigrant workmen, who had but recently landed in America, were frequently sought after by plant superintendents in order that the latest technical advances in European manufacture might be learned.

Though markets were broadened in the first half of the nineteenth century by transportation advances, such as the beginning of railroad

building, yet they were comparatively narrow, compared to the markets that we know. Though the limitations of state boundaries meant nothing when compared to those of national boundaries in Europe, yet it was unusual for one manufacturing community to attempt to sell in another, except as it possessed some product not made in the other locality. Means of communication usually did not allow national distribution to be attempted. Nevertheless, markets were constantly broadening, and groups in the community began to arise to take charge of the marketing function. The development of the merchant class, which, we have seen, was in existence long prior to the formation of the manufacturing-capitalist class, quickly progressed. The structure comprising the jobber, wholesaler and retailer, with which we are familiar, grew up. Trade customs came to be established, as in branches of the textile industry, whereby all goods were produced primarily for a middleman, who took over all phases of the marketing.

A financial group arose, whose business it became to provide the means of carrying on the rapidly increasing transactions between these newly established groups of industrial society. The larger the competitive area over which a product was distributed, the more necessary became the services of the financier, and thus his growth to a sometimes dominating position in industry followed the increasing development of markets.

The characteristically small plant of this period was dominated by the owner, who was usually to be found in the factory during working hours, except when engaged in distributing his product. Workers found opportunity for personal contact with the owner of the business, and frequently for personal expression of their craftsmanship in the finished product, even to the extent of changes in design. The owner, whether he was on good or bad terms with his men, was well known to all of them, sometimes by the half-affectionate title of " the boss," and generally to many of the older employees by his first name. The worker was accustomed to remain at his place of employment for years, the personal contacts which he formed with the owner doubtless proving to be one of the strongest inducements in this direction.

Despite this opportunity of personal contact, labor troubles were numerous, and could hardly be called less violent than those now experienced. They were, however, sporadic, unorganized, and frequently due to the struggles of those who were personal losers by the industrial upheaval. Strikes occurred, many being caused by the early attempt to bring over into manufacturing the long hours of agricultural industry. It was many years before even so short a working day as the ten-hour day became at all common, and this was secured only after constant struggle. These early labor troubles may be looked upon as some of the growing pains of the factory system, and bear little resemblance

either in organization or in aims to union-employer struggles of the present. There were many attempts to form unions, some of which were successful for a time, but there were no national union organizations such as those with which we are familiar.

In this early period, manufacturing had hardly come to be thought of as involving much art or science, but was regarded primarily as a vocation. Utilization of scientific methods of developing operations had but begun, and close checks on leakages through accounting methods or management control were not even thought of under the competitive conditions of the times.

The period of great industrial expansion. The second period, that of the great industrial expansion, saw the United States rise from the position of a novice among nations in manufacturing industry to the position of the greatest manufacturing nation of the world, both in diversity and amount of product. Abundant natural resources, a rapidly increasing home market among people whose wants were large, and manufacturing ability which seemed to combine and intensify the variety of skill of the many population elements caused this growth in manufacturing industry.

The United States, a new country, willing to absorb and further develop new ideas, readily secured the benefits to be found in the logical development of the factory system. The division of labor which resulted from the first machine inventions was further increased as manufacturing method under the factory system developed. With each invention of a machine, division of labor was likely to increase. Transfer of skill to machines made possible the reduction of manufacturing costs, which brought with it wide markets that made possible increased production. As production increased, economies in the purchase of materials, indeed, the control of sources of supply of materials, became possible. Integration of the various steps in production of raw materials and manufacture of more and more refined products became possible. As size of industries increased, more and more capital could be attracted which made possible further development of integration, mass production, and by reducing costs, widened the markets. Capital began to be used as a means of founding and financing huge enterprises which could not have existed without its aid and without the manufacturing conditions of the factory system. In the adaptation of all these conditions, the lead came to be taken by the United States, which, instead of being the pupil, came to be the teacher in most phases of manufacturing promotion and manufacturing method.

With the foundations of a huge domestic market already laid in the first period, the development of means of transportation and communication, beginning early in the last half of the nineteenth century and reaching

to the present, literally made all the world a neighborhood in which products purchased are made through a radius of thousands of miles. While markets have been broadened, the ability to secure raw materials has likewise expanded; even workers move from one locality to another as conditions dictate, and thus competitive conditions have been made over. The service rendered industry by improved communications cannot be measured; without the growth of the railroad map and railway shipping accommodations and service, taking place simultaneously with the development of the telegraph and telephone, which make possible the dissemination of news and market information, there could have been no such industrial growth as was witnessed during the past half-century.

The invention, by Watt, of the steam engine helped to revolutionize industry, but the development of the dynamo and electric motor created real industrial power. The first machine inventions brought in the factory system, but constant inventions and improvement increased the capacity of industrial plants to undreamed-of proportions in those same industries. Invention during this second period of American manufacture founded great new industries, filling new wants and creating whole new markets. A rising standard of living broadened the market, which for these and other products might previously have seemed glutted. We look upon the great iron and steel industry as the barometer of our trade conditions, and yet, ninety years ago, the iron on railway tracks consisted of a thin strip laid on top of wooden or stone rails, while steel frame buildings are a development of the last thirty years. The use of electricity for power, communication, and light has founded but recently one of our great basic industries. The successful use of the gasoline engine for transportation purposes has given us within the last twenty years the automobile industry, one of the truly great industries of the country, whether we consider it from the standpoint of value of product, number of people employed, or manufacturing method. The beginnings of all these industries, the improvements in manufacturing technique, the improvement in product which followed and broadened the market for each, are all characteristic of the second period in American manufacturing.

As manufacturing grew, and new industries developed, there was developed the "American type" of manufacturing, standardized, interchangeable parts. This, though perhaps the most clear-cut illustration of the way in which American manufacturing industry struck out for itself along new lines and broke the lines of custom and technical knowledge that formerly held it bound to Europe, is after all, only an illustration of the change that was taking place. American manufacturing had become weaned and, developing so rapidly under conditions so different from those of Europe, soon found itself practically free from the bonds of European influence. Indeed, it became so free and so accustomed to

look upon American methods not only as different, but as best, that it actually lessened the opportunity for export sales in competition with European products by refusal to observe trade customs or even trade desires in foreign markets.

If the manufacturing industries of the United States could have grown more gradually, and if there had not been the seemingly limitless markets for nearly every new product introduced, because of the tendency to break away from tradition, there would have been a strong possibility of working out industrial conditions which would have been favorable to all concerned and with which all might have been satisfied. With the enormous growth of manufacturing, incident to the expansion of a minor manufacturing nation in days when manufacturing was small to the greatest manufacturing nation of the present, there came an attendant train of circumstances to which can be traced many of the industrial problems that now must be faced. Chief among the causes of these problems have been the growth in the size of individual businesses and the change in their form to corporations, the steady and, until recently, almost unregulated influx of immigrants, and the development of labor unions.

The growth of markets, necessarily involving greater production, brought about rapid increase in the size of those plants whose products had become secure in the approbation of the purchaser either through high quality or low prices. Those plants that, either through patent monopoly or good production or distribution methods, began to grow, grew very rapidly. The increasing size, the necessity for additional capital, and the legal advantages incident to that form of organization, such as permanency, all combined to aid in the growth of the corporate form of organization. However, it is the difference in the size of organizations rather than in their form, which is mainly responsible for the changes in owner-worker relationships that occurred during the second period. Many corporations, formed only to secure the incidental legal benefits, retained their former owner or his successors in such active management as to make the new form of organization unnoticed from the operating standpoint. On the other hand, in many corporations the owners became so distinct from the operators as to cause the growth of many new operating problems that have become intensified during the third period in American manufacturing under the factory system.

The rapid growth of manufacturing created a demand for workers, which could not be filled through the ordinary growth of population, and this, even more than the agricultural opportunities afforded in the United States, led to an influx of immigrants unique in world history. As public lands became scarce, these immigrants more and more came to this country to fit into the manufacturing field, and increasingly came

to be of the classes and races of Europe most difficult to assimilate. This flow of immigration, as yet largely unassimilated, was at first looked upon as an unmixed blessing by the manufacturer, in that it furnished him with a labor supply at low cost. It has, within recent years, in many trades, proved to be the basis of much of the industrial unrest that the manufacturers have found to be one of their greatest problems. This second period, the period when expansion was the keynote for everyone connected with industry, has furnished a majority of the problems that have had to be courageously faced in the third period. Of these problems, the existence of large, unassimilated and un-Americanized groups of workers is one of the most important.

The growth of labor unions, organized along present lines, is another of the developments of this period. They exist as the crystallization of the labor movements of earlier American industry and of forces in existence since the guilds. They also exist in direct response to conditions caused by the growing impersonality in the operation and incorporation of manufacturing enterprises, as well as in response to the necessities of self-protection brought about by the flooding of the country with immigrants in the last part of the nineteenth and beginning of the twentieth century. As corporations have grown in size, labor organizations have grown in size, that they might be able to match strength with the employers. As organization, national in scope, has been achieved among employers, similar organization has been perfected among workers. Many employers to-day must deal single-handed with national unions, but yesterday many workers had to deal single-handed with fully organized local employers' organizations and sometimes with national organizations. This is a partial explanation of the "organized employer, organized employee" situation as it is found at present. The crystallization of the movement is to be found only in the third period, its beginnings and causes largely in the second period.

Fundamental conditions which called for attention to operating methods. Even as, after wars of conquest, nations have found it necessary to go carefully over the captured territory inch by inch and put it in order, and while doing so have had to change their army of occupation from one organized for conquest to one organized for administration, so the manufacturing community in the United States has had to go carefully over its conquests and reorganize. It has had to reorganize at the same time that it has been making more conquests, conquests in the field of new markets, in the direction of new inventions, of mechanical improvements, and conquests in the bettering of social conditions of the worker. Manufacturing industry in the United States expanded rapidly through the help of many separate, unorganized forces, some of which were normally opposed. Because of the youth of the industries, attention was

devoted to each of these forces, such as betterment of technique or widening of markets, without much thought of correlation. A great amount of individual experience in operating methods was accumulated through years of toil, but there was little dissemination of this experience to others, and really little conscious thought of this experience as possibly helpful to others from an operating standpoint. Technical experience of value was at times interchanged, though not as freely as now, but operating experience was not interchanged, nor was it classified. There was need for the consideration of plant management as a factor in manufacturing success.

During the end of the second period there had been developing, as we shall later see, some very definite strides toward bettering management method, but these were unknown to practically all industry and unrecognized by those portions which knew of them. This condition was likely to continue as long as expansion was the keynote of industry, as long as markets were abundant, as long as technical developments were progressing with the same rapidity that had characterized them in the past.

The opening of the third period. Attention to operating methods. Gradually, a decline in ready availability of markets seemed to creep into American industry. Manufacturers in many lines began to find a sales situation indicating that normal productive capacity in their industries was somewhat ahead of the market. Market demands increased with growing population, increasing the standards of living and the development of new products, but manufacturing capacity had increased greatly also. Newer plants with better machinery were hard competitors of older plants, even with rather definitely established trade outlets. In the struggle against tightening competition, manufacturers came to depend less upon the finding of new marketing districts and more upon an intense combing of older markets. Rivalry between manufacturers increased to the point where plants began to lie idle for lack of orders, or combined with their competitors to reduce distributing and other overhead administrative charges, at the same time turning their attention to economies in productive management. National advertising came to be a major factor in distribution methods, in an attempt to enlarge markets by creating consumer demand, and at the same time to wrest custom from competitors. Great inroads began to be made on the jobber-wholesaler-retailer method of distribution, which previously had characterized American industry. These changes marked the opening of the third period.

Changes in market conditions were probably only the force which gave the necessary impetus in directing attention toward operating methods. It is logical to assume that, with the growth and development of factories, attention would, after a time, become focused on these as it

had previously been directed to manufacturing technique. However, what we may term the scientific industrial age began to arise out of the changed conditions, and attention to methods of operation is the outstanding feature of this era. Savings through better organization, savings through stricter accounting, savings through more effective distribution, and savings through more effective factory operation, all are considered, thrashed over in executives' meetings and adopted as a portion of plant policy, where some years ago they were hardly thought of.

The tendency toward the creation of larger enterprises has continued and to some extent increased. At least, there is a definite tendency to create "interests," which control many enterprises from a central location. The giant corporation, owned by hundreds or thousands of investors, has become common. This implies control of many plants through operating or managing representatives of the owners, financial representatives, sales representatives, and production representatives. In this lies an additional cause of attention to operating methods. In such types of organization attention to management is essential and fundamental; huge organizations must be constructed so that they will function as smoothly as the huge machines in the factories. The gears of policy of the finance, sales, and production organizations must mesh as closely as the driving gears on the factory lathe. They can only be made to mesh if minds and hands guide them to that end.

The World War is frequently assigned as the cause for the change in emphasis to operating methods. It did aid in many ways, and yet the changes have been gradually coming about during the past thirty years. The war emphasized changes in conditions which had already begun to occur. It also, of itself, brought about certain conditions which have resulted directly in gaining greater attention for operating methods. Many conditions occasioned by the war may be said to be entirely temporary in character and as such do not require mention here. Temporary boom times and temporary times of great depression following the war may be considered in that category. However, the war fundamentally affected American industrial trends in at least two ways: first, by the changes in products manufactured during the war period— in many cases forced changes in operating methods within factories; and second, by fundamental developments in labor relations occasioned by the war.

Effects of the great war on American Industry. Factories that had been making one article or group of articles for years suddenly found that these were of no service in carrying on the war, that priorities and restrictions against the use of certain materials practically prohibited their manufacture, and they turned to the making of entirely new articles that previously they perhaps had not even heard of. In the normal course of events, their old production methods might never have been changed,

because they were prospering quietly; but they were now face to face with a new production proposition. They were forced to think in new channels, to think of operating methods to produce the new products quickly. This habit that they formed in war times they carried to peace times, and it is unusual to find a factory that was engaged in making war products that has not had its peace-time operating methods changed through being forced out of the well-worn ruts of years of operation. There were other similar effects of the war, as we shall see later when considering the management movement separately.

The war ended with distinct unrest among a large percentage of the wage-earning group. A considerable part of the immediate unrest could be traced rather directly to many men who had been taken from the work-benches for the first time, shown other fields and, in general, made desirous of a change, regardless of what that change might be. The desire of many workers to shift jobs, merely for the sake of shifting, during 1919 and 1920, was an example of this. However, something more fundamental came from the war than the mere desire to change jobs. Its essence is not to be found in particular strikes, or even in the following "open-shop" movement on the part of many employers. Both these manifestations of strength had been experienced before the war and will probably be experienced many times again. Neither was that unrest, usually termed Bolshevistic, that was experienced in some instances, the most important type. The individual plant manager could do little to counteract this, although groups of managers, acting in accord, were instrumental in allaying it. Rather, there grew up in the minds of all, employer and employee, an increasing sense of the importance of the individual worker in industry, a feeling that the human element in industry was fundamentally important. Whereas, prior to the war, the emphasis in management matters tended to be given almost entirely to the physical aspects of management, such as plant, equipment, materials, etc., the emphasis since the war has been largely on the human element, or on the way in which the human element will react to changes in other phases of management detail. Since the war it is a brave man among managers, and a foolhardy one too, who has thought of the physical aspects of management without first evaluating them in terms of the human element. This change may have been brought about by the underlying motives of our entrance to the war, by the attitude of war labor boards and their rulings, by a growth in public interest in labor disputes or by a combination of all these factors. The results will be found in such ideas as workers' representatives, collective bargaining, and the greater space and appreciation given the workers' point of view in all management literature.

There has come to be an appreciation of the fact that wage-earners must have the same desire to work steadily for and produce for "the

organization" that they had for "the boss," and that there must be found something to substitute for the appealing force of "the boss's" smile. New departments in industrial establishments have had to be created, not only to improve processes and methods of production, but to improve the human understanding within the organization, to acquaint each with what the others are doing and why they are doing it.

These developments direct attention to one of the outstanding factors in many recent labor disputes. At the beginning of the factory period the employer and capitalist were one and the same. As the system developed and capital came to be accumulated, the capitalist frequently ceased to carry on the business that his capital had made possible. With the growth of the great corporation it has been pointed out that this differentiation between the capitalist, or owner, and the manager, or operator, has become more and more intensified. This has been of advantage in building up a technique of management, in creating a class in the community whose paramount interest has been the effective operation of industrial concerns. But the remoteness of the owner of the business and his lack of contact with daily operations has at times caused the wage-earners to fail to see the economic service rendered by the former in the business, and has been the underlying cause of many labor disputes.

This condition, in turn, has led to the focusing of much attention on the industrial possibilities that lie in the relatively small plant, the plant of from two hundred to five hundred workers. Here the possibility of retaining contact between the actual owners, or those who determine policy, and the wage-earners, when coupled with painstaking attention to operating methods, frequently gives the most effective results. Many of the illustrations that we shall consider will be drawn from organizations of this type. In these smaller plants, where the dealings are ordinarily directly between those who determine policy for the plant and the wage-earners, the interests of all within the organization are bound together and the energies of all are directed toward making a success of its business. This can be advantageously contrasted with the impersonal "drive from above" so frequently found in large corporate organizations that are a portion of "interests."

Yesterday's era was that of the rise of the factory system, of the growth of machine production; to-day's era is that of management in industry. Yesterday we had employers who were but employers; to-day the employer must also be a manager, delicately weighing the large variety of detail elements that come to him and reaching decisions from careful analysis of them all. The industrial scene has changed and the change is becoming more apparent year by year. There are some employers, some large corporations even, that are living in the era of yesterday.

Some may live in that era and still exist because of particularly favorable circumstances that give them monopoly power along some of the lines already described; but others live in that era without such protection, not knowing that it has passed, that the industrial world has moved onward another step into the era of scientific factory operation. Many such enterprises are "taken over by their bankers" during times of depression.

As we study the true meaning of management and the problems of management, let us not fail to remember that this age of management is new. It has only been a few years since people in industry have thought or talked in the terms of management. Though industry is centuries old, the factory system has existed for only a little more than one century, and the bases of modern industry, which have given rise to the present management problems, for only a few years. By keeping these considerations always in mind, we shall have a better background on which to attack management problems. We shall realize that the very newness of present economic conditions is the cause of many of the problems that exist, that the science of management is a new science, with even its shallower waters unsounded, a science wherein every factory, every organization, is a new world, and every worker in industry a potential explorer and a prospective discoverer.

CHAPTER III

THE MANAGEMENT MOVEMENT

Coincidently with the rise of interest in management matters among the general industrial community, there has been developing what may best be termed " the management movement." This movement, which involves personalities, has been progressing together with industry and yet separately from it, actuating industry almost from without. Although attention to operating methods has outlined for us broadly a true era in industry, yet by considering this management movement separately it will be possible to trace more definitely the various stages and paths in the changes that have been going on. Before discussing management methods, with the few thoughts already presented on what management really is and its broad historical background in mind, a discussion of this management movement will aid definitely in clarifying issues, and possibly to some extent in eliminating doubts.

The management movement would, in any event, have come about within a period of perhaps a quarter-century. Of that we can be certain. It had a firm foundation in necessity, and what that foundation was we have already ascertained. However, the exact form of the movement and its starting place was, as is not unusual, determined by the life work of a great man, who, seeing around him the need for the development of management, even as many other men probably saw it, was not content merely to sit and look on, but began the intensive study of corrective measures, which finally led to the development of the science of management, of which he is recognized as the founder.

Frederick W. Taylor. Whatever branch line the management expert may be working in at the present time, or whatever methods he may use in his particular development of the science, the true expert, who has studied the history of the movement, as well as the detail of method, will always gladly say that his work is but the development of the foundations laid, between 1880 and 1890, by Frederick W. Taylor. Taylor was the man with the vision, the father of modern scientific industrial management, not only in the United States, but throughout the world. There never has lived a man whose individual work so largely influenced the operation of so many plants in so many and diversified industries as did the work of Frederick W. Taylor. His first work was small in itself

and finally largely voided by opposing factions in the organization. His influence, though not dormant, was both consciously and unconsciously disregarded for twenty years; and yet, in the development of management methods, it has been greater than that of any other single man.

Dr. Taylor was himself strongly influenced, when still comparatively young, by knowledge of the work of Mr. Henry R. Towne, President of the Yale and Towne Manufacturing Company, who began the application of new management methods as early as 1870 in the plant of that company. It was probably the example of Mr. Towne that caused Dr. Taylor to direct his efforts to the organized study of management as a science and as a profession. But, although Towne may have been the pioneer, Taylor was the great leader of the movement. At the time of Dr. Taylor's death, Mr. Towne himself referred to him as " one of the world's discoverers and creative leaders," and as " the creator of a new science."

Early steps of Dr. Taylor. In 1882, after transferring from the offices to the shops of the Midvale Steel Company, in Philadelphia, Taylor was promoted to machine-shop foreman in the Midvale plant. During his previous experience as a workman, Taylor had been constantly impressed by the failure of many of his fellow-workers to produce more than a third of a good day's work. Wages had been on a piecework basis, and the men were afraid to let the management know how much work they could really do, for fear that the rates would be cut. When Taylor became foreman, he was determined to work out some system of management by which the interests of the management and of the men might be made as nearly as possible the same.

The constant thought in the mind of Mr. Taylor in those days was that the difficulty at the root of the whole matter was lack of knowledge of what actually should constitute a day's work. How could the man be held accountable for his full duty when the management had no idea of the man's capacity? It was on this thought as a foundation that most of his writings, researches and influence over other men were erected. He found that management did not really manage. It would be necessary to entirely change its attitude toward its responsibilities in this direction before it could be expected that the workman would change his attitude with relation to his work. Taylor felt that the management was asking the worker to do its work as well as his own. His efforts to secure information at Midvale, concerning ways in which management might really manage, enabled him to develop what he termed the " duties of management," that guided him and many others along newer industrial paths. These duties were changed in phraseology by Taylor from time to time, but their substance was as follows: [1]

[1] "Principles of Scientific Management," F. W. Taylor, Harper & Bros., p. 36 (1919 edition).

First: The development of a science for each element of a man's work thereby replacing old rule-of-thumb method.

Second: The selection of the best worker for each particular task and then training, teaching and developing the workman; in place of the former practice of allowing the worker to select his own task and train himself as best he could.

Third: The development of hearty co-operation between the management and the men in the carrying on of the activities in accordance with the principles of the developed science.

Fourth: The division of the work in almost equal shares between the management and the workers, each department taking over the work for which it is the better fitted; instead of the former condition in which most of the work and the greater part of the responsibility were thrown on the men.

Taylor remained at Midvale until 1890. While there he also carried on early experiments in the development of high-speed steel. His discovery of this product, in which he was associated with Mr. Maunsel White, ranks as an achievement equal to the founding of the modern management movement. The work which he did on high-speed steels was in fact an outgrowth of his attempts to find the right way to do jobs. When Taylor left Midvale it was largely due to factional differences within the organization and this fact naturally led to the undoing of much that he had accomplished. Nevertheless, even to-day many of the practices in the machine shops of this plant can be traced directly back to the time that Taylor was first working with management methods there.

For several years Taylor did not have an opportunity to carry on, upon a large scale, the work that he had begun at Midvale. Though engaged in a number of undertakings in which he aimed to improve management method—several of which, by the way, were largely concerned with improvements in cost accounting—there was no one great work carried on in one plant.

At the Bethlehem Steel Company, beginning in 1898, for three years, with the assistance of a large and competent force of assistants, he reorganized the management and methods of two of the larger machine shops and the foundry, and at the same time completed the development of his metal-cutting experiments. It was at Bethlehem that interesting studies of pig-iron handling and shoveling were made, which since have become classic in the field of management. One of the more important of the wage-payment systems was also developed during this time. Taylor's early experimental work in management can be said to have been done on the same sound scientific basis as his metal-cutting experiments, and any task which he attacked was handled by him in the same manner. This fact accounts for the fundamental nature of his conclusions. As an

evidence of the type of work he carried on, Taylor once stated in connection with his metal-cutting experiments that he and his associates had made nearly fifty thousand recorded experiments and many others of which no record was kept. In studying the laws of metal-cutting there were cut up under his direction more than 800,000 pounds of iron and steel. His experiments in management were conducted on the same scale.

After Taylor had been at the Bethlehem Steel Company for about three years there was a change in the directorate and executive management of the company. The group who came in were unfamiliar with, and apparently antagonistic to, the methods pursued by Taylor and his staff. Taylor and his associates left. This withdrawal was followed by changes in method by the new management, and since it so closely followed the upheaval at Midvale it cast a shadow on Taylor's work which it took some years to live down. This very largely accounts for the slow development of his ideas during the immediately succeeding years. The manufacturing community as a whole, if not actively hostile, were at least reluctant to give a trial to ideas which had been practically discarded at two of the largest steel plants in America. But Taylor's work had trained a number of disciples, who thoroughly believed in his ideas and work, and there naturally were enough manufacturers who were interested in these new ideas of management to allow for a steady, if slow, growth in the application of these management principles during the succeeding decade. Among the more important plants in which Taylor or his direct associates worked in this period were the Tabor Manufacturing Company and the Link-Belt Company of Philadelphia and the United States Arsenal at Watertown, Mass.

Dr. Taylor's later life. Shortly after the beginning of the twentieth century, Taylor withdrew from actively installing management methods and began to philosophize and generalize on his experiences. The far-reaching significance of his principles and methods became clear to him and he began the task of transmitting them to others through writings and addresses. His writings of this period have become the very foundation of modern management literature. The first and best known of these is "Shop Management." This book was first published in 1903 under the auspices of The American Society of Mechanical Engineers, having been read at a meeting of the society in June of that year. In December, 1906, Taylor presented as his Presidential Address to the same society his other masterpiece, "The Art of Cutting Metals." From that time until his death on March 21, 1915, he devoted himself almost completely to the task of spreading the gospel of scientific management.

After Taylor gave up the active practice of management installation, there quickly appeared a number of his direct followers to carry on his active work. These men have become known as the "Taylor School"

in management methods work because their close association with the leader of the movement has caused them to be largely guided in their work by Taylor's own methods. The influence of Taylor was guiding, at this same time, other men in distant parts of the United States, and even of the world, along paths which led to the same goal, but nevertheless took somewhat different courses in reaching it. In the hope of avoiding some of the pitfalls that Taylor's detail methods had fallen into at times, these other methods which were developed, frequently seemed radically different from those of Taylor. As to devices utilized, they sometimes were different, but the principles they aimed to reach were his, although the executive might not always have been conscious of this.

Taylor's position in the management field is that of the first explorer. His researches, because of his personal ability, carried him personally further than might have been expected. Unfortunately, his abilities did not include that of selling his work *in toto* to many besides those most closely associated with him, who were always able to see the careful thought and study behind all his conclusions. Being the leader, and years ahead of the industrial community, he has had associated with his name some of the most violent opposition to the introduction of new methods in operation. This became particularly true, because he was the first exponent of a cause which, though it has not grown beyond his imagination, has, as he most of all would wish, grown beyond the control of his immediate followers and his or their particular methods.

The public, and even the large majority of factory executives, especially outside the metal-cutting trades, had not had their attention focused on scientific management by any of the early work of Taylor or the development work of the Taylor men or others. Although there had been a general tendency toward improvement in management method, in 1910 but little was known of scientific management. In 1911 thousands had a general idea of what it meant, although their concepts were necessarily frequently warped.

The railroad rate hearings of 1911. This change came about through a startling announcement made by Louis D. Brandeis during hearings before the Interstate Commerce Commission, late in 1910, concerning certain railroad rate increases. Justice Brandeis, who at that time took the aggressive against the proposed increase, stated that it was unnecessary because if the railroads of the United States should adopt scientific management the rate increase would be unnecessary. He explained that by this method a saving in operating expense could be accompanied by an actual raising of the wages of the railroad employees. In the same hearings, Harrington Emerson, an installer of management methods who had had wide experience in the shops of the Santa Fé Railroad, stated that the railroads could save $1,000,000 a day by paying greater attention

to efficiency of operation. These two statements, both coming from men of undoubted reputation, were given wide publicity and electrified the entire country. The general public of the country was as interested then as now in lower railroad rates, and this new talking point against increases was more than interesting to them. It was peculiarly fortunate for the growth of the management movement that public attention was first focused upon it in connection with an industry in which the public was so vitally interested and with which it came into such daily contact as railroading.

Only a few days after the introduction of the evidence, the early December magazines gave much space to the dramatic testimony of the witnesses, and proceeded to give accounts of what scientific management was and what the results of its installations had been. Arguments began, debating societies debated the question, industrial executives were quoted as to why they thought scientific management was good or worthless. In March, 1912, the first "efficiency" society was organized in New York for the purpose of applying the scientific management principles of "efficiency" to every department of life, and scientific management as an element in the industrial life of the United States had come to stay.

The "efficiency men." Modern management shortly came to be known under the term "efficiency" and interest in "efficiency" became so widespread that it nearly caused the death of the management movement. It did retard it. "Efficiency men," fakers in every sense, who promised short-cuts to profits through panaceas, and whose knowledge of management was as shallow as their vision was narrow, sprang up overnight. They managed to kill the word "efficiency" in American industry most promptly, and they nearly permanently injured the management movement. They failed for various reasons: first, they usually had no knowledge on which to base their efforts; second, if they did have the personal experience to qualify them, they usually lacked the broader concepts which would have permitted their work to be successful. They did not pay sufficient attention to the workers' point of view and they did not or would not co-operate with the regular organization. They tried to run rough-shod over the older members of the organization until the title of "efficiency man" became everywhere the key-word for concerted opposition. Recently the "consultant in management," with far different ideals and qualifications, has replaced the "efficiency man," with very effective results.

Another retarding influence on the growth of the management movement at this time was the fact that all the literature on the subject concerned the metal-cutting trades. When a manufacturer in another industry became interested in modern management and began to read Taylor's writings, or those of his co-workers, he soon discovered that

everything definite about modern management was expressed in terms of metal-cutting. It was, therefore, but natural that they failed to look, under the surface of the devices and terminology employed, at the principles involved and said that "it didn't apply to them." It was some years later before this difficulty was even partially overcome.

In the general growth of the management movement, the leadership that had been Philadelphia's was largely lost. Sections of the country which were less conservative along lines of management method took to the new ideas more readily and in larger proportions than did eastern sections. New industries which were developing, such as the automobile and allied industries, had a made-to-measure opportunity to develop management method along with manufacturing technique. These were largely located in the Middle West. The Middle West grasped at the opportunity of increasing effectiveness of operation that was offered by management method and gradually developed, in many scattered localities, methods of operation which, though built up on the same firm foundations as those which served the early leaders of the management movement, were nevertheless constructed along newer and bolder lines. Of the illustrations of this work, the best known is that of the Ford Motor Company, whose examples of the economies incident to standardized operation, continuous assembly, and newer wage-payment methods have profoundly influenced the whole of American industry.

The management movement at the beginning of the war. At the time that the United States entered the World War the management movement may be said to have been in a condition of deflated interest but gradual growth. The necessities that were outgrowths of our entrance into the war quickly changed this situation to one of awakened interest and rapid growth. The declaration of war by the United States, in April, 1917, made it incumbent upon this country to organize itself for the prosecution of the war immediately and effectively. It meant the organization of the industries of the nation for the one common purpose. Without attempting to lay blame, or to decide whether there was blame, it is nevertheless true that in the several years of the war prior to America's entry into it, nothing had been done toward getting American industry ready to shoulder the war burdens, other than working upon the European orders which certain American manufacturing plants had received, not as a matter of Government policy, but generally almost contrary to the Government policy. It was, therefore, found necessary at the beginning of our participation to start from the very ground in organizing the nation for war production. Government arsenals could supply but a small fraction of the war materials which were immediately needed.

Those who were in control of Government supply bureaus very quickly found it to advantage to employ for the organization of wartime industry

men who had made a business of organizing peace-time industry. It was, therefore, usual to find in Washington that the men who were taking active charge of the expansion of those bureaus were emergency men, brought in for that specific purpose, and the regular Government officials were contenting themselves with giving these men advice on governmental procedure, or executing such procedures as might be developed. This was even more true in the organization of industry to aid the Government than it was in the reorganization of the bureaus themselves. The men who were brought in to do this work were proved executives, and there was a scramble among the supply bureaus for those men who had proved themselves competent in the distinct field of management. Practically every man who had ever written an article on management was to be found connected with one or the other of the Government bureaus before the war was two months old. In this attempt to secure the management talent of the country it was unfortunately true that some of the bureaus were not in a position to select the capable men from the incapable; but nevertheless there was built up quickly a corps of management experts, such as had never before been gathered together. These men, accustomed to the freer ways of the business world, frequently chafed under the binding restrictions of governmental red-tape, and therefore, kept constantly in mind the performance of old tasks in new ways.

Brought into contact with these men at this time were hundreds of other industrial men, called also into Government service, who as yet had not come directly into contact with the management movement. These men became the aides to or co-operators with those of wider modern management experience and soon came to have first-hand knowledge of their methods. Although it is true that some of these men returned to industry with rather a horror of attempting the newer methods, the usual reaction was otherwise. To most of these executives the war became an apprenticeship in the ways of modern management, the knowledge gained being directly utilized after their return to industry.

The effect of the war on the management movement. The effect of the war in changing operating methods in American industry and causing a rapid growth in the management movement can hardly be over-estimated. Reference was made in the previous chapter to the effect on plants forced out of time-worn ruts by the war. The same effect was experienced by executives as individuals. As the production forces of the Government were demobilized, executives returned to their peace-time tasks with new ideas and new concepts, and, above all, jarred out of the habit of doing the same thing in the same way day after day for years.

The war served the management movement in another way. It broadened the very men who had been the leaders in the movement in prior years. Particularly is this true of the attitude of the manager

toward the worker. Whereas much of the opposition to scientific management had been from the worker, because he felt that it was but a further attempt to deprive him of some of his traditional skill, previous to the war, management men had a tendency to regard this as merely one more barrier to be overcome, and not to deal with the fundamentals of the situation. The broadening powers of the war seemed to aid this situation somewhat. Management men seemed now to possess a more fundamental concept of their position toward labor, and with rather a feeling of trusteeship of the rights of labor as well as a trusteeship of the rights of the owners of a business, which they had long felt. This has developed side by side with the growing feeling of the importance of the human factor in industry.

There has also developed an appreciation of the difference in reaction likely to be experienced from the workers as various phases of management work are undertaken. For instance, one management problem to which much attention has been given in recent years is the lighting of the workplace. If the manager is seeking to improve the lighting of the workplace, he will find no opposition from any worker or body of workers. He may receive requests for better lighting from the workers, but there will most certainly be no permanent objection imposed to the changing of light conditions in the shop for the better. This is representative of the type of change where the manager is sure of the full co-operation of the worker, and the type where he will expect no marked opposition.

On the other hand, another of the problems of the modern manager is to ascertain just how much production should be attained by an average worker in a given space of time. This knowledge is fundamental in a large number of the decisions of the manager. To secure this information there has been devised the taking of time-studies, usually by means of the stop-watch. Large numbers of laboring men, and particularly labor organizations, have expressed their disapproval of the taking of time-studies. It would be foolish to think of the taking of time-studies without the full co-operation of the workers, and yet the manager here is likely to find himself bitterly opposed by the worker. So his management problem in this case takes on an entirely different aspect from the one of improving the lighting of the workplace. In both the human factor must be regarded, but from entirely different angles.

The consultant in management. Since the war the spread of the management movement has been extremely rapid and the development has been along what seem to be comparatively sound lines. "Efficiency" has passed on and in its stead has come soundly developed management work that considers the fundamentals of all problems, that is based on long perspective, and that takes into account the necessities of both

booms and depressions. Management has become the profession of the plant executive, not merely the profession of a few who specialize in it. Those who do specialize in management fit into the scheme as specialist co-operators with the managing executives of industry. The consultant in management has become firmly intrenched as one of these specialist co-operators. He fills a very real, although a new niche in the halls of industry. He is a combined product of the age of management and the age of specialization in industry. He specializes in management and sells his services, either along general or specific management lines, to the executive who is in charge of the enterprise. He brings to one plant the knowledge of many, and he serves to rehabilitate run-down concerns by bringing in the refreshing stimulus of an outside viewpoint. He serves the same purpose as does the blood-transfusion operation at a hospital, and at the same time his greatest work is carried on before the patient-concern gets to the point of weakness such as characterizes the hospital patient who undergoes the blood-transfusion.

The specialist, or consultant, in management is not the only expert who is a product of recent development in industry. He has come in after the certified public accountant, who occupies practically the same position in the accounting field that he does in the managerial, and his advent is not so recent as that of the income-tax expert, whose duties frequently partake more of the legal nature than they do of the accounting. But some of the more recent developments in the field of industrial consulting have become rather specialized. For instance, there is the type of industrial consultant who advises only with regard to the construction of a new building or the remodeling of an old one, specializing in such matters as the type of building construction, fire hazard, the routing of the product through the factory, etc. Or there is the still more recent development, the outgrowth of the labor conditions just referred to, of the consultant who deals only with labor matters. Mushroom consultants have sprung up who are but remnants of the efficiency men, but in the main the consulting field is developing along far sounder lines than did the efficiency movement.

Together with the growth of the consultant in management has come the growth of the idea of having an " inside man " in management. This inside man is a specialist in management who is continuously on the payroll of the employing concern, and who performs the same type of tasks as the consultant. He has no particular duties connected with the actual administrative work of the concern, but acts entirely as a specialist in management, advising and installing new ideas. This development seems in some respects to many to have more possibilities than the development of the consultant, as the latter frequently has to spend so much time in the plant in order to be familiar with local conditions, as to become

himself almost an inside man for the time being. If he does not devote that amount of time, he is apt to have a high percentage of error in his decisions.

The effect of the depression of 1920 on the management movement. In the business depression which began in the late months of 1920 the management movement found a blessing, though at the time it did seem to be considerably in disguise. Soon after the beginning of this depression, factory managers, being forced to reduce operating costs to the very minimum in order to be able to survive, frequently eliminated production, personnel, or other similar staff departments which have been usually looked upon as part and parcel of the management movement. These departments were usually eliminated with regard for only one factor, immediate payroll necessities. For a time it looked as if such adjuncts of management work were only fair-weather factors. As the period of most severe depression passed and prosperity began slowly to return, it was found frequently that those features which had been eliminated from an organization could well be spared. Often they were an after-war over-development of a good principle, badly worked out. But plants found out that they needed personnel departments and production departments, if they were established on a sound basis. Examples of well-managed plants that had weathered the storm best of all, through low inventories and quick turnovers made possible through highly developed organizations, came to be well known, and the sound basis of management work as applied to a particular plant came to be better understood. The feeling that correlation of various departments within a business was of primary importance and operating methods within the departments came afterward was a distinct outgrowth of the experiences of many plants during the depression. Labor, even union labor, often previously hostile to management developments because of misunderstandings or poor operating methods in particular plants, came to be more friendly because of the depression. It saw that there was less unemployment in better-managed plants, less wild wage-reductions, more sympathy for the point of view of the worker from the executives who were working in accordance with modern management principles. All in all, the depression served to squeeze the water out of the management movement and to put it on a firmer, sounder, more appreciated basis in all portions of industry.

The future of the management movement. The management movement has progressed remarkably when its youth is considered. It has grown rapidly from the early beginnings of Frederick W. Taylor, and it seems destined to continue to grow because of the logical trend to operating methods which we have seen is a fundamental condition in American industry. There are a number of factors which are combining to insure steady progress in the development of the field of management. Among

these are the growth of societies whose membership consists largely of plant executives and whose interests lie entirely with management problems, the increasing literature, both periodical and book, on management subjects, and the attention being devoted by the next generation of factory managers, now in educational institutions, to management as a study.

Just as the growth of scientific education in colleges during the last fifty years has aided in revolutionizing American industry, so the growth of management education is likely to aid the management movement in further revolutionizing it. In 1915 there were not five courses in management given in American universities. To-day practically every business and engineering school in the United States is offering courses in Management. While this extremely rapid growth of management instruction has been in response to the demand from industry, yet in many cases it has led the demand, and has, through its graduates, called the attention of industry to the strides that have been made in management in other sections of the United States. It must be put down as one of the most important developments in management in recent years. Particularly is this true in the instances where industry and the colleges have co-operated in management education, for in practically every case where this has occurred, the combination of practical and theoretical instruction has resulted in very distinct advances in the management field.

Probably the best criterion for the continued growth of the management movement is the interest of the general public in management matters. Management literature is no longer confined to technical publications, but a large portion of the public is informed of strides toward better management through the columns of the daily press and popular periodicals. Each time that public interest is threatened through some industrial upheaval such as a strike in a basic industry, editorial comment points directly to industries and factories where better management has solved similar problems. The general public, as well as the enlightened factory manager, is coming to know that a solution of a specific controversy between employer and wage-earner lies deeper than mere adjustment of the problems immediately incident to the particular difficulty. It is coming to be daily better understood what the hidden forces are which make for smooth and effective operation of industrial establishments, and that these forces, though sometimes highly technical in their development, must be successfully co-ordinated by what is known as management to bring about industrial betterments and the industrial peace so sought after.

PART II

PLANT ORGANIZATION

CHAPTER IV

FUNDAMENTALS OF ORGANIZATION

One of the primary steps in the development of management in any enterprise is proper organization. After the business has been conceived and the broad policies which are to be pursued have been established, before any operating methods may be devised, at least a skeleton organization must have been developed. Operation and operating methods depend entirely on the organization which has been built up A business which is well organized has gained an excellent start toward effective operation. Organization is the foundation of most operating management steps. Proper organization simplifies management developments which are impossible in a business which is not well organized. Much of the criticism which has been leveled at certain steps of management in particular enterprises should rather be leveled at the faulty organization which existed, and which prohibited the groundwork on which these steps should have been based. In a business in which the organization is good, if forward-looking steps in management are tried, they will usually succeed with little difficulty.

Ordinarily the poorly constructed organization is typified by executives at the top who are continually struggling with a mass of detail, who point to their terrific tasks, and perhaps feel that they are not able to take a vacation once in five years. The organization which is well constructed is typified by the smooth flow of detail throughout the executive organization and by chief executives whose minds are free to think constructively.

The fundamental power for the operation of a business is provided by its organization. The manner in which routine flows through a business may well be contrasted to the flow of potential power through water power developments. The poorly constructed organization is like the power plant of the old-fashioned factory on a river where a portion of

the stream is diverted through a canal and passes over a single water wheel which turns the machinery of the factory. Organizations of this type provide for action by only one man, and he is enabled to take care of but a portion of the potential power that flows along the course of the business. The well-constructed organization is like a great power plant that is set up in a dam thrown entirely across a river. Such navigation as is carried on upon the river is taken around the dam by means of a canal. Every ounce of available energy in the river is utilized by diverting the water to a number of penstocks and then through various turbines, thus utilizing all the potential power of the river and making it possible to place in action one or several of the generating units as required. Organizations which are like this provide, by means of alternate power sources in the form of executives in the organization, for the utilization of all potential power. The breakdown of one unit in the organization does not cripple its activities.

Basic considerations in organization. Prior to discussing specific fundamentals of good organization or particular types of organization development, it will be well to think of some basic considerations in organization. By organization is meant the structure of the enterprise, especially from the standpoint of the development of the duties and functions of the parts thereof. The purpose of building up an organization is to provide for a daily routine and effective operation of a business or department with a minimum of direction from above. Effective organization, which is the means of securing operating power in a business, if well developed, tends to make the securing of that power very nearly automatic. Organization carries out its purpose by determining the scope and limits of each individual or group of individuals in a business undertaking, together with their relationships and contacts with each other. By a consideration of fundamentals and types of organization, an executive builds up a structure for his business or department which is peculiarly suited to its needs.

Organizations must be developed primarily with regard to peculiar conditions within the business. The application of the fundamentals of organization will differ widely in two different businesses. The size of a business, particularly, has an effect on the way in which the organization develops. Although the differences in structure of a huge business and a small one may not be as great as might be expected at first, nevertheless the duties and functions to be performed, as well as the method of arranging an organization to perform them, will be found to be unlike. This is particularly true because of the large number of co-ordinating functions which are necessary in the development of a structure for a great business enterprise. On the whole, with the small business it is possible to develop essentially the same type of organization as may be developed

in the large business, except that the duties of several people in the latter will necessarily have to be combined in the former.

The type of business will be found to greatly affect the development of the organization. Thus it will be found that steel plants, textile mills, paper mills, or refining plants, although they have the same fundamentals to deal with, will necessarily apply them in different ways. In a manufacturing business, if the product be standard, ordinarily the organization will need to be differently constructed than if the product be diversified. The same amount of business may be handled with fewer chief executives if the product be standard, because it is easier to delegate authority in such businesses. Even the location of a plant may affect the exact way which the organization is constructed. The effect of location on the personnel may demand this.

The building up of an effective industrial organization rests on the proper observance and application of a series of " fundamentals of organization." These fall into two main groups, primary fundamentals and operating fundamentals. The primary fundamentals must be considered by the executive when building up the scheme of organization and prior to giving any considerable attention to the operating fundamentals. The operating fundamentals may be said to be executive in character. They put into effect the concepts of the man who worked out the primary fundamentals. They aid in the application of these primary fundamentals to the business. The primary fundamentals of organization may be thought of as dealing with those phases of management which consist of policy and organization building. The operating fundamentals may be thought of as dealing almost entirely with the operating phase of management.

The fundamentals of organization. The primary fundamentals are fourfold: first, regard for the aim of the enterprise; second, the establishment of definite lines of supervision; third, the placing of fixed responsibility; and, fourth, regard for the personal equation. The operating fundamentals, which will not be spoken of in detail at this time, are four in number also. They are, first, the development of an adequate system or method in work; second, the establishment of adequate records; third, the laying down of proper operating rules and regulations; and, fourth, the exercise of good executive control.

The operating fundamentals of organization lay down the groundwork for the third of the major divisions of management—operating the enterprise. The first of the primary fundamentals, regard for the aims of the enterprise, serves to tie the developed organization closely to the determination of major policies, which is the first of the three major divisions of management. Thus, through the construction of an effective organization, major policies are followed in operations.

Regard for the aim of the enterprise—the first of the primary fundamentals. Regard for the aim of the enterprise is most important at the time that the first steps are taken in the building or development of the structure which is to be termed the organization of that enterprise. In no two businesses are the purposes of the management or the conditions of operation entirely alike. The working out of all other fundamentals of organization must bear direct relation to this one and must take this fundamental fact into account. It will be easiest to consider this fundamental of organization by considering businesses of diverse natures wherein it can be seen that the organization structure must necessarily be different in order to meet the conditions involved in the operation of the businesses. Let us consider the organization which is necessary to take care of the unusual occurrence wherein speed of attainment and not cost is the dominating factor. Such an instance is clearing of a railroad right-of-way after a wreck. All thought of ultimate cost is thrown aside and an organization is constructed which, by main force, will have but one end in view, namely, clearing the tracks and letting through the trains at the earliest possible moment. Compare this to the organization which is necessary for the operation of a huge manufacturing plant which is to remain in existence for many years, whose activities are not only numerous but varied and must all be carried on with due relation to each other. It will be readily seen that the organization structure required in the case of the railroad wreck will be far more simple, far more direct, than will the structure which is required to carry on the work of the great manufacturing establishment.

Length of life of the organization and desired speed of results are important factors in the development of its structure. Thus, the organization necessary to construct a number of reviewing stands for a large parade, which will be put up quickly and taken down promptly, may be far simpler than the intricate organization of a construction enterprise which involves the putting up of a huge office building, or hotel, which may be months in course of construction and may involve the interplay of a very large number of skilled trades. It will be possible to discuss this fundamental somewhat more fully after some of the concrete methods of organizing are clearly in mind. It is sufficient to point out at this time that as the purpose or condition under which the enterprise operates changes, the organization must change likewise. In determining the aim of an organization, major plant policies must be carefully thought through.

The establishment of definite lines of supervision. The second of the primary fundamentals of organization, namely, the establishment of definite lines of supervision, lays down the lines of control which are exercised over the personnel of the enterprise. These lines of supervision may be looked upon as lines of authority, as paths along which orders

flow. They are also the paths along which information necessary to the execution of particular tasks is communicated.

In laying down the lines of supervision, the organizing executive has two main problems at hand. First, he must determine the type of organization which is to be used. There are a number of rather definite ideas in organization structure and from among these he must choose the one which he feels best fits his organization at hand. These particular types of organization structure, as already stated, will be spoken of later (Chapter V). Secondly, he must not only determine the general type of his organization, but he must carefully develop and mold the outlines of the type as they can be best applied to his particular business enterprise. In developing his definite lines of supervision he will have to give careful attention to the fourth primary fundamental—regard for the personal equation.

A lack of definite lines of authority will result either in an overlapping of duties or in gaps which are not taken care of by the organization as constructed. The gaps or overlaps may be thought of as horizontal on an organization chart as between the lines of authority which have been laid down, as contrasted to vertical gaps or overlaps which will occur if the third of the primary fundamentals, namely, the placing of fixed responsibility, is not adequately handled. Lack of definite lines of authority will result in dissension between members of the organization, and thus personal attention of chief executives must be given to the problems which arise. Individual members of the organization will fear that their territory has been infringed upon, or they will fear to infringe upon the territory of some other member of the organization.

In considering the establishment of definite lines of supervision, there are several lessons which can be learned by industry from the pure old-line military organization of the army. One of these lessons is the definiteness of control through lines of authority as it existed in this old-line organization. It is true that this was at times carried to extremes, but nevertheless, properly handled, there is much to be learned from it. Secondly, the development of lines of supervision implies the necessity of training subordinates who are able to take the place of superiors who for some reason may vacate their positions. The army organization is careful to have a properly trained supply of new men always available to fill a superior position which may be vacated.

Definiteness of control through the establishment of lines of supervision implies the idea of tapering authority. It implies the development of a group of executives along this line of supervision, each one down the line having somewhat less authority in scope, and somewnat more direction of detail. The workman who bungles his work in a well-organized enterprise hears from his job boss, not from the president of the company,

even though the president may be passing through the workroom at the time that the mistake is being made and even though he may notice the mistake. The job boss, although he has control over the small piece of the business undertaking, similarly is not charged with error in case the undertaking was wrongly conceived and proved to be generally unprofitable. The lower in an organization a man is, the more it seems necessary for him to have a direct superior to whom he may look as a final court of appeal in matters involving methods of his work. This does not, however, prohibit the development of a staff department which may advise everyone concerning one particular phase of the business.

A substitute for each executive within the organization is essential. This substitute must be available to act in case of illness or enforced absence of the superior, and must be capable of taking over his work in case of death or change of duties of his superior. In the industrial army, as in the fighting army, the company without a head seldom reaches the objective. If there be always a capable substitute, as determined by the lines of supervision which have been developed, it will always be possible to have a head for the shop or the department just as relative ranking always provides a head for the company of infantry. However, if a plan of substitutes for executives is being developed, it is essential that all members of the organization must have complete confidence in the purpose behind the plan. If they gain the feeling that the plan is merely a club to be held over their heads, so that if they do not prove successful at any time they can easily be removed, the plan will fail. Members of an organization can be shown the legitimate purposes of the plan. These are in the first place, to always have an executive on duty, and, in the second place, to offer opportunity for advancement, either as executives leave or as the business grows.

The placing of fixed responsibility. The third fundamental of organization is the placing of fixed responsibility. The accurate placing of fixed responsibility eliminates vertical gaps or overlaps of responsibility along the lines of supervision which have been laid down. The more responsibility can be definitely given to subordinate executives, the easier it will be to develop substitutes for each executive. The more responsibility for co-operation with other members of the organization is made definitely a portion of the responsibility assigned to the individual member of an organization, the easier it will be to co-ordinate the operation of the various phases in the business.

There are three main results which are achieved through the accurate placing of responsibility. First, fixed responsibility acts as an incentive to a subordinate. If he knows the field of his responsibility and if he knows that his superior is holding him to it, fixed responsibility in this connection makes possible stimulative encouragement and reward for

responsibilities well carried out. Secondly, fixed responsibility aids in the general speed-up of work. It immediately becomes possible to know to whom communications should be addressed or which executives should be called into conference on any particular topic. The breakdown of routine caused by having some important executive cog in the organization unaware of programs which have been laid down or decisions which have been made is thus eliminated. Thirdly, the accurate placing of responsibility assists in developing discipline as a means of control. All good executives utilize discipline to control to a certain extent and, if responsibility is carefully fixed, failure to meet responsibility can be more easily disciplined.

Regard for the personal equation. The fourth of the primary fundamentals of organization is regard for the personal equation. In developing lines of supervision and in fixing responsibility, it is not possible to consider only the factors of the business which would ordinarily demand that decisions of a certain nature be made. It is necessary to take into account the personnel which is available, or which can be made available. Arranging an organization should be looked upon more as a game like chess and less as a game like checkers. Frequently men have been moved across the board of the industrial game as if they were all of equal value, as if one could readily replace the other, as if one could always fit into an organization niche when another had gone, merely because he was a man of approximately the same salary or had previously performed approximately the same duties. Men are of different values and work together in different ways. They fit into the team-play in various ways. Men are not square pegs or round pegs to be fitted into square holes or round holes, as is frequently said. The concept that a job is of a particular kind and that it is necessary to find a man to fit that job is frequently wrong. It is more frequently necessary to consider the man who is available and then draw the outlines of the job to fit his capabilities.

Merely assigning duties to men does not lead to the accomplishment of tasks and, therefore, it is not possible to draw organization charts and find men to fit them. Some enterprises with branch establishments have gone on the theory of organizing each branch in exactly the same way, of having an organization chart for each branch organization which is exactly similar. It is a peculiar but outstanding fact that in some of the branches of such organizations it will be found that everything is working smoothly, that everyone co-operates with everyone else; while in other branches jealousies have arisen, dodging responsibilities is prevalent, and the organization seems to be generally ineffective. The difference in the various branches as between mutual help or mutual distrust can be explained partially, in some cases, merely through the personality of the branch manager, but if conditions are carefully investigated, it will fre-

quently be found that there are other causes. The main consideration is that the organization has been outlined, the lines of supervision have been drawn, the responsibilities have been fixed and the personal equation, the abilities of the men, has not been taken into account.

It will not be possible to enumerate all of the factors which must be considered in giving proper regard to the personal equation as a factor in organization. Merely to mention some of them, however, will direct attention to others. There are three such factors to which attention can be deservedly directed. In the first place, proper consideration must be given at times to thoughts of home and outside worries. It is well enough to say that men or women should leave their social affairs outside of business buildings, but human nature unfortunately frequently does not permit of this. Men whose families may have quarreled over domestic problems, such as the marriage of the son of one to the daughter of another, do not make good co-workers ordinarily. Intelligent executives have had frequently to give consideration to matters of this kind when building up or rebuilding their organizations. Hidden reasons for failure of an organization to work together are frequently found to be similar to this. Some men are large enough to bury such differences. Most men, particularly subexecutives, are not. Secondly, the habit and inertia of the personnel of an organization must be considered. New organizations are easier to construct than are old organizations to reconstruct, for just this reason. The "efficiency man," who developed so much trouble for himself, frequently did so because he refused to consider habit or inertia of personnel as a reason to warp lines of supervision to meet conditions as he found them.

Thirdly, there must be co-operation and team-play, and the best way to secure co-operation and team-play is through some man with qualities to lead in the right direction. This man must be found and put in a position to lead; though to exercise his influence he need not necessarily be at the top of the organization, but merely in a position where he may radiate leadership toward the goal of the enterprise. Successful enterprises have such men within their organizations. If the leader be properly placed in the organization, the other executives and subordinates will work harder, more whole-heartedly, and in a more sustained manner for the purpose at hand. One of the best examples of this type of leadership which was ever known was to be found in the person of Mike Murphy, track coach and football trainer at the University of Pennsylvania. Although he was not head coach of the football team but only trainer, candidates for the team would be heard time and time again to say that they were "doing it for Mike" or "backing up Mike." His power to enthuse the men, to get them to cooperate and work as a team was a fine example of true organizing ability.

There is in organization work a type of individual somewhat different from the leader who may be termed the "strong man," who is frequently very valuable to an organization, at least temporarily. The strong man is a man at or near the top who brushes aside the carefully developed lines of supervision or responsibilities which have been fixed and, through his own dynamic guidance, operates the organization, or a large part of it. Such men are dangerous in long-enduring organizations because, ordinarily, in case they pass on, substitutes cannot be found for them. The attitude of reorganization experts frequently has been that the pet plans and policies of such men have ruined many concerns and that a man who cannot work with the fundamentals of organization has no place in a modern organization. This attitude is, in the main, justified, and yet there are many times when the "strong man" is an important adjunct to a business. In new businesses when policies are being determined, such an autocratic head is often far superior, for purposes of getting an organization going, to a group of individuals without his driving power, even though they may work along theoretically correct lines of authority and responsibility. The combination of strong driving force from the top and well-developed fundamentals of organization through the ranks is one of the best, if not the best, organization bases which can be found.

Operating fundamentals of organization. The operating fundamentals of organization have been previously noted. They are the development of an adequate system, the establishment of adequate records, the laying down of proper operating rules and regulations, and the exercise of good executive control. These fundamentals, following chronologically the primary fundamentals in their application, put life-blood into the framework which has been set up through attention to the primary fundamentals.

The development of an adequate system. Considerable confusion frequently develops in the minds of many who speak of organization matters, in that they speak of some of these operating fundamentals, which are so easily observed, as if they themselves wholly comprised organization. This is particularly true of system. The operating fundamentals are concrete in nature, as compared to the more abstract primary fundamentals, and, being easily seen by the casual observer, are easily misunderstood for organization itself. Thus it is not at all unusual to hear such a conversation as the following:

"Mr. A. certainly has his plant well organized."

"Yes, his system is wonderful."

This clearly indicates a confusion in the minds of the speakers between "organization" and "system."

System is a part of organization, not the whole. As an operating fundamental it helps to bind the whole mechanism of organization together.

System is the existence of order and method in all parts of an undertaking. It relieves the man at the head of the details of execution, and is a bulwark that prevents the lines of authority which have been laid down from being overstepped. It brings work to executives with the preliminary steps completed and ready for their attention, thus enabling them to apply their entire time to matters of maximum responsibility. When all factors in a business are moving in a regular and accustomed routine, the waste of time and effort that is involved in repeating the preliminary steps of the solution of any problem is avoided It is the function of system to provide for this routine, to provide in advance for all detail work, preliminary or consequent. Furthermore, instead of allowing important steps to depend on some man's fallible memory, system, as through the establishing of a tickler device, makes automatic provision for initiation of all action necessary to complete the steps.

Although system implies order in work, it does not necessarily imply economy. A procedure may be highly systematic, but still very wasteful. This has caused many highly developed systems to fall into rightful disrepute, but should not cause any attempt to eliminate properly worked out systems from an undertaking.

The "exception principle"—a development of system. System supplies the motive power for what has been termed the "exception principle" of management. When operating under this principle, instead of the head of an enterprise, a department, or even of only a few men, attempting to act personally on each case coming under his general jurisdiction, he acts on the exceptional matters only. Frequently recurring matters are made routine, a system of checks and balances having been developed in accordance with responsibilities already fixed, so that these matters may be handled entirely without reference to the executive himself. The exception principle demands that the manager receive reports of all portions of the enterprise under his control. These reports are summarized as far as possible, and even these summaries are carefully gone over by the manager's assistant, if he have one, prior to presentation to the manager for his attention. The assistant can make notations of additional information which he may possess on given points. If he sees that some matter in which the executive is particularly interested has not been properly handled, he may return the report to the compiler thereof for further treatment in that regard.

By the operation of the exception principle, all routine matters may be handled by the executive in a few minutes, and thus he is enabled to devote his entire time to the more important matters which should, by right, demand his personal attention. He may give more detailed consideration to the peculiar cases, which do not fall under the routine. In devoting his attention to these cases, he is enabled to work over them

to such an extent that he frequently can correlate them, and develop the points of similarity and difference in them, until they, too, are classified and no longer may be termed exceptional, but are routine. He is also more free to consider the broader line of policy of the section of the business under his control. There are many cases where departments, or even whole concerns, have come into grave difficulties for no other reason than that an executive so tied himself up with routine matters, due to the absence of proper system, that he failed to notice the general trends occurring in his branch of the business. It will generally be found that the operation of the exception principle, through system, gives fuller opportunity for the development of the other fundamentals of organization, such as fixed responsibility. The executive is enabled to learn more of the possibilities and capabilities of the various members of his staff, and is thus enabled to better distribute responsibility among them.

System, though tangible when contrasted with the primary fundamentals, is less tangible than the other operating fundamentals of organization. It is not as easily seen as are records, nor easily read, as are rules and regulations. Yet the effect of system is clearly noticeable when it exists. There is, in fact, a condition of management generally known as systematic management, which represents a considerable advance over rule-of-thumb method, and yet which is far from modern scientific management. Systematic management represents a rather full development of system within an organization, without a corresponding development of the more thoughtful processes associated with modern management. In plants where this type of management can be found it will be usually discovered that the executives are methodical in the extreme, and in some departments the smoothness of operation will be extremely high. In systematic management it will usually be discovered that, though considerable attention may have been given to all the fundamentals of organization, the greatest stress has been given to the execution of orders through the development of a complex, but generally effective system. It is in this type of management that the importance of the office clerk and bookkeeper reaches the zenith, as compared to the development of the manager, or thinking guide of the enterprise.

The development of system is always difficult, sometimes impossible, without proper lines of authority and definite responsibility. In many ways system may be looked on as the working out of procedures to tie these together. In the development of a system it is always important to keep this in mind, or it may be that the system will become overdeveloped in one particular or underdeveloped in another. Such maldevelopment may easily result in the hampering of the work of one member of the organization at the expense of his neighbor. If the system is worked out in direct relation to the lines of authority which have been

laid down, the responsibilities which have been fixed, and the aims of the business as determined, such mal-development will be impossible. For instance, in developing various phases of system for the enterprise it is essential to think whether the business is to be developed to produce or sell luxuries, products of normal quality, or primarily quantity products. Is the product to appeal to the purchaser by its superiority, its high value or because it is good enough for the purpose it serves? Thus, in developing an inspection procedure or system you would be profoundly influenced in your tolerances and your extent of laboratory analysis by such considerations. A study of this relationship indicates, in a measure, the paramount importance of the primary fundamentals and the fact that the effect of system is to aid in carrying them into effect.

Reports as an aid in developing system. One of the bases of the successful operation of the exception principle, or in fact, of system in general, is the securing of adequate reports from subordinates. A report discharges the responsibility of a subordinate to his chief. It is the completion of a task, the end of an assignment of work to be done. Just as an order should communicate all information necessary for execution, so a report should communicate all information essential to administration.

The prime requisite of a report is that it shall serve some really useful purpose. Many times this fact has been lost sight of by the executive who delights in keeping a "memory book" of the history of his business or department. Such men require the submission of reports which are of slight, in any, practical value. If reports are to be an aid to the operation of the exception principle, this danger must be avoided. Otherwise a condition will soon arise in which the reports will not be read and will not serve as the basis for action. If a good executive finds reports accumulating on his desk which he does not look at week after week, he should recognize this as a danger signal. The reports in such a case are either inadequate, are being rendered too late for action, or should be discontinued entirely.

The submission of reports is one of the most important functions of the young man who is just entering the field of management, and who secures a minor executive position. The ability of such a man to properly present the subject at hand for the consideration of his chief is one of the most unfailing ways to secure the approbation of the latter. The reason for this is easy to ascertain. The ability to prepare a concise report, which is directly to the point at issue, covers all the necessary facts, and at the same time does not waste space in the inclusion of non-essential details, is the best possible evidence that the subexecutive has an understanding of his work, has completely thought through and analyzed the situations that have confronted him, and that, in short, he has success-

fully mastered his job and is the type of person to whom more responsibilities may be given.

Reports to executives should be always concise, should give the general facts and general conclusions, if any, in the first few paragraphs, and then should follow these with such elaboration and data as are necessary in the particular case at hand. All information that is susceptible of comparative treatment should be so handled, so that the executive may see trends without having to look up prior reports or other older information. The experience which is detailed in the report should, wherever possible, include information concerning what others in similar businesses are doing, as well as information concerning changes and happenings within the organization itself. This is merely the extension of the comparative treatment concept beyond the boundaries of the home organization.

Reports corollary to the development of system may be written or may be entirely statistical. The development of statistical reports involves the same problems and may be worked out along the same lines as that of written reports. Statistical reports, to be effective in the development of system, must readily call the attention of the executive to the unusual figures, and not unduly draw his attention to figures which may be considered normal.

Organization reports may be periodic or special. Special reports are prepared on some unusual subject by special assignment. Periodic reports are regularly presented at stated intervals. Examples of these are: The Analyzed Profit and Loss Sheet (presented to the general management by the accounting division); the Sales Reports (including those presented to the general management by the sales division, and those presented to the head of the sales division by the departmental or territorial chiefs therein); the Factory Production Reports (including various types, as with the sales reports).

The Analyzed Profit and Loss Sheet would include all items which give any indication of the trends in the business from the profit standpoint. The Sales Reports would include such items as (1) Information concerning the goods that must be sold and the profit at which they must be sold in order to secure the desired profit on the balance sheet at the end of the year. (2) Actual results, territory by territory, showing volume, profit and expense of doing the business. (3) Business conditions in each territory in which the concern transacts business. The Production Reports would include: (1) Progress on all work in process, including both work being manufactured for stock and special work on customers' orders. (2) A report on the causes of hold-ups in production that have occurred. (3) A report on any developments in labor relationships during the period under consideration. These are merely examples to show the nature and scope of periodic reports.

The establishment of adequate records. Records, although differing from system, frequently inject the life-blood into the latter which allows it to survive. System without records does not usually prove successful. Records are even more tangible than system. They are definite, and therefore their provision, maintenance and improvement are more simple than in the case of system. Records give the history of operation of the enterprise. Their preparation and use make possible the elimination of guesswork from management. They are an operating fundamental of organization because they are used after the primary fundamentals have been established, and by the organization that has been built up in accordance with the concepts of its primary fundamentals. Records are an instrument used as the basis of action, or at least as the basis of reports on which action is taken.

In the provision of proper records the executive has before him an opportunity equal to almost any other in the field of management. It is easy to get too many records of an unintelligent sort; it is equally easy to provide too few records. The provision of just the right type of records in just sufficient quantity is one of the clearest indications of good organization. Too few records are costly, too many records possibly even more so. Once the idea of the necessity of records is secured by those in charge of the enterprise the immediate danger is the development of "red-tape." "Red-tape" is of three general kinds: first, too many records, including some unnecessary ones and duplicate records made up by different departments; second, too many forms to secure essential information which might be secured on a smaller number by combining several; third, the unnecessary refinement of information for record purposes. Ordinary processes of manufacture, distribution or administration may easily be halted, while absolutely accurate figures are secured, when approximate information would serve the needs of the executive. Records should always be ordered compiled with a view to these red-tape dangers.

Not the least important phase of record collection is the form on which the record is secured. As previously stated, there should be as few separate forms as is possible. A multiplicity of forms results in their frequent loss, and consequent absence of information that is needed because one of many forms relating to a particular problem is not at hand. Forms should be of standard size wherever possible, in order that their handling, as well as their filing, may be expedited. They should be so constructed that they are easily read, with the most important information standing out most clearly when the form is filled in. An integral part of the idea of "adequate records" is to maintain them physically so that may be secured when needed.

One maxim with reference to records, as well as other devices of management, is that they are only valuable to the point where the cost of their

collection is less than the savings which their collection will effect. Much interesting data can be collected at large cost, and if the manager is of the type who likes to know every possible point about the plant from every possible angle, it is generally not hard to secure the information. It is likewise not hard for the manager, by securing the information, to turn the plant into a laboratory for the collection of such data, rather than a business enterprise.

One type of records which usually justifies their cost of collection, however large, if their value be determined in broad rather than in narrow terms, is cost records. Not only must the cost and profits of each article be clearly shown, but the expenditures and success of each department must be carefully investigated, so that it may be definitely known on which articles profits are being made, and which departments are doing their share in the profit-making on the article, as well as which departments are costing more to operate on the individual process than they should. Proper cost analysis gives invaluable data on conditions demanding reorganization, and on the operation of the organization, as in results achieved through certain responsibility previously placed. The larger and more complex the organization, the greater is the importance of securing accurate costs. As an establishment grows in size and complexity, it becomes increasingly difficult for the man at the top to analyze conditions from observation alone. Conditions of competition and the knowledge of the essentials of careful organization are tending more and more to cut down the difference between cost of production and selling price. To-day rough judgments concerning the cost of production or distribution are fatal. The failure to gauge a business step upon accurate data may easily result in a mistake that will first make profits dwindle and then turn them into a loss.

It is essential that all records, of whatever nature, be compiled so as to indicate trends. Records, like reports, which do not give comparative information are frequently valueless. Certain it is that records which include comparative information are far more valuable than those which do not.

Laying down proper operating rules and regulations. The third of the operating fundamentals of organization, rules and regulations, is the tie that binds together all the other fundamentals. It defines the scope of the application of system to the various portions of the lines of authority which have been built up. It provides methods for the utilization of the records, and in innumerable other ways it functions to knit the organization together into a unified whole. The establishment of exact rules, either verbal or written, permits authority to be actually delegated, and system to actually work, because the superior and the subordinate both have a definite concept of their respective duties and

responsibilities. One of the ideals of good organization, namely, the handling of routine without direction from above, is thus provided for by the executive handling a matter only once, then laying down a rule for its future handling, thus making it a part of routine. Written rules and regulations may be general in character, touching only on the broad outlines of business policy, or they may be more detailed in character, taking the form of a "standing order," which may provide the exact method of performance of every task in the business. In developing rules and regulations care must be taken to insure that they are changed as conditions change, and that they are not so detailed as to entirely eliminate individual initiative and the good effects thereof from the business.

Rules and regulations include proper instruction of the personnel in all the features of the business. Unless written rules are verbally and intelligently interpreted at the time of their promulgation, and the spirit behind them, clearly defined, it is likely that too often they will be observed to the letter, when that interpreter of all business regulations —judgment— should be used. Good organization demands judgment on the part of the employees to a greater extent than even poor organization, because with the latter poor judgment is not so glaring a defect. It is therefore essential that in the development of the fundamentals of organization, and in their promulgation through rules and regulations, this be strongly stressed. Further discussion of methods of promulgating rules and regulations will be considered in Chapter VII on "Organization Instructions."

The exercise of good executive control. The last of the fundamentals of organization, the exercise of good executive control, provides the lubrication which makes possible the functioning of the power plant represented by the organization as a whole. If the organization be regarded once more in the light of a power plant, this time almost of any other nature than a water-power plant, the primary fundamentals may be looked upon as the machinery itself; the other operating fundamentals, except executive control, may be looked upon as the fuel; and executive control may be looked upon as the lubrication. The more perfectly the organization is developed, in other words, the more intricate the power plant, the more necessary is intelligent executive direction, in order that lubrication may be provided when and where needed.

The executive in an organization has two main tasks to perform, organizing and supervising. His organization task, although possibly the more important of the two, is not the one which takes the majority of his working hours. The task of supervision or executive control consumes a majority of his time and consists, in the main, of making decisions and handling the exceptional cases as they arise in a way which will promote the smooth operation of the organization.

The idea of good executive control implies the prior development of the primary fundamentals of organization. Without these, executive control involves one-man supervision of most of the details of a business with all the attendant difficulties.

Evidences of good executive control are not always apparent. They imply creation, by the executive, of a state of mind in subordinates which allows the executive, by suggestion or by his detailed knowledge of the job, to eliminate difficulties as they arise.

Poor executive control is easily observed and comes to light in the inability of an executive to be rid of the papers which come to him for decision, in the man who makes snap judgments, in the man who shows his ignorance of the relationships of the various phases of the business to his own, or in the man who treads the path of custom. The purpose of an executive's presence is to bring together two links in the chain of organization which, for some reason, have come apart, or to cause two gears in the organization which are clashing to run smoothly. To perform his function of control the executive must, therefore, be primarily a leader. Good executive control implies good methods of supervising which, in the last analysis, means leadership.

CHAPTER V

THE DEVELOPMENT OF ORGANIZATION TYPES

The same fundamentals of organization can be applied in very different ways. These differences in application have brought about the development of rather distinct types of industrial organizations. The development of these types corresponds rather directly with the changes which have come about in American industrial history and which have already been described.

The industrial organization of the first period was usually an organization of the military type, that is, authority flowed directly from the boss to various subexecutives in charge of particular phases of the business, and from them to workers. In the simplest form of this military type of organization the boss was directly over all of the workers in the organization except certain of the factory workers who might be under a foreman. The following diagram illustrates this:

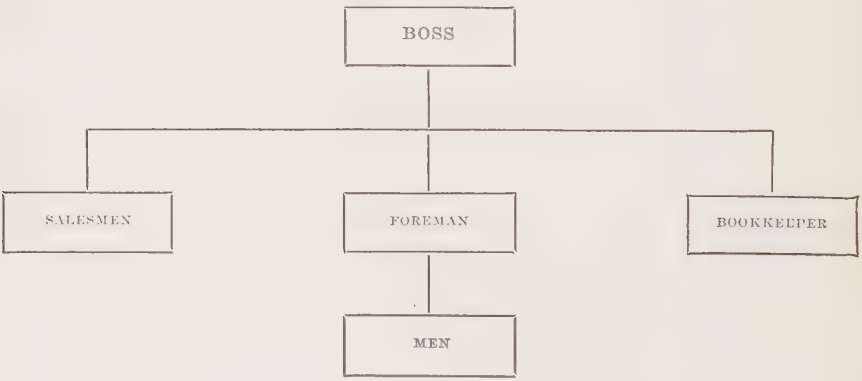


Fig. 1.

The second period of American industry did not bring with it any great change in methods of organization from those of the first period. Such changes as came about merely represented growth in methods utilized during the first period. That is, the military method of organization still continued predominant and such changes as were made were

brought about merely by the growth in the size of businesses, and merely represented a delegation of authority over subordinates on the part of the executives near the top in the business enterprise. This will be illustrated by reference to Fig. 2.

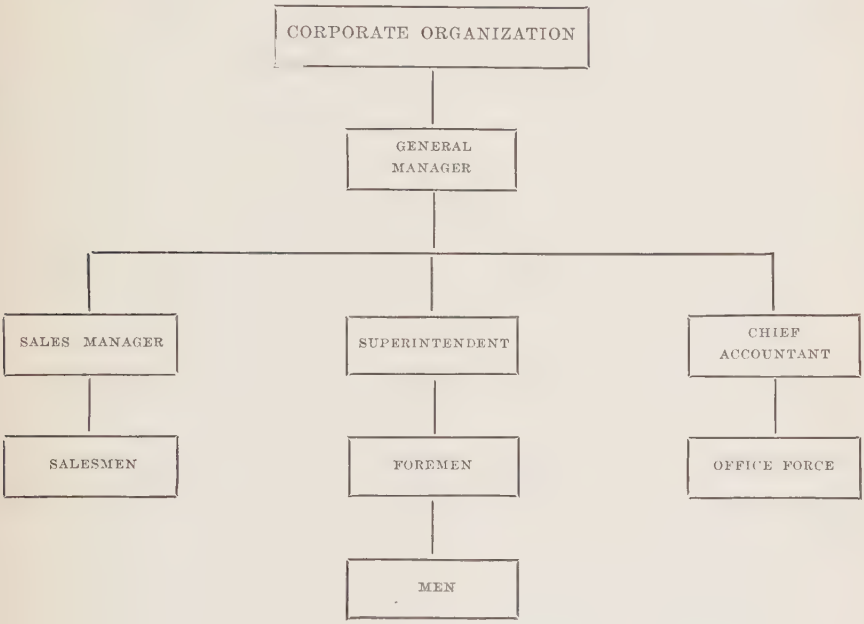


FIG. 2.

The third period in American industry has brought with it the development of the functional idea in management and, as an outgrowth of that functional idea, the development of the line and staff or departmental organization as we know it to-day. Functionalization has brought with it basic changes in the structure of industrial organizations, as indicated in Fig. 3. To thoroughly understand these, it is necessary to consider the causes which brought them about and the methods which are utilized in building up organizations to-day.

Nowhere are the concepts back of the development of the functional idea in management so clearly illustrated as in their application to the field of what may strictly be called shop operation, particularly in the field of direct supervision of the workman. In order to see the reasons for the development of this idea, as well as the reasons for some of the reactions against it, a business demanding the most elaborate type of organization will be selected. The manner in which this organization may be adjusted and simplified to meet any given circumstances will

then be readily apparent. The type of business chosen for illustration is a medium-sized metal-working establishment building miscellaneous machinery.

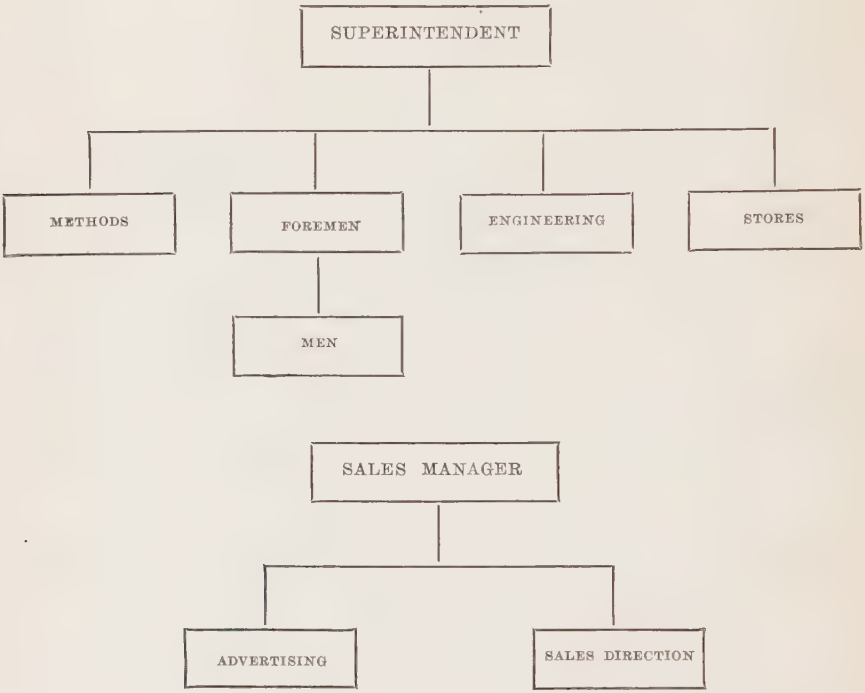


Fig. 3.

Defects of the military type of organization. The "military" plan of organization has already been discussed and it has been pointed out how this plan involves the direct flow of authority from the top of the organization to the bottom. In a business organized in accordance with this method, the duties of the foremen, gang bosses, branch managers, etc., are extremely varied and call for a great amount of natural ability. In fact, to make a success of an executive position in a concern which is organized in that manner, it is usually necessary to have years of special training in addition to unusual personal qualities on which to build.

Frederick W. Taylor pointed out that "it is because of the difficulty —almost the impossibility—of getting suitable foremen and gang bosses, more than for any other reason, that we so seldom hear of a miscellaneous machine works starting out on a large scale and meeting much, if any, success for the first few years." He further states that, "This difficulty is not fully realized by the managers of old and well-established companies,

since their superintendents and assistants have grown up with the business, and have been gradually worked into and fitted for their especial duties throughout years of training and the process of natural selection. Even in these establishments, however, this difficulty has impressed itself upon the managers so forcibly that most of them have of late years spent thousands of dollars in regrouping their machine tools for the purpose of making their foremanship more effective. The planers have been placed in one group, slotters in another, lathes in another, etc., so as to demand a smaller range of experience and less diversity of knowledge from their respective foremen." [1]

Despite this effort to meet the situation by regrouping of machines, it nevertheless was found that it was practically impossible for a new establishment to secure suitable superintendents and foremen of the business organized along the lines of the military plan. The regrouping of machines, itself, was a mistake in many plants as the manufacturing process could be better carried on if the machines were laid out as formerly.

As business gradually tended more and more to specialize its workers, including its executives, this difficulty has been found to be almost insurmountable in the organization of manufacturing establishments. This was to be expected, since it is practically impossible that foremanship technique advance as rapidly as industry itself. Most establishments, after years of experience in overcoming the opposition of the heads of departments, foremen and gang bosses to new methods of work, have determined that it is the system of organization rather than the individuals in question who have been at fault. They therefore have attacked the problem from the standpoint of discovering the errors in the military type of organization and changing the organization form before almost any other change is made in the plant.

To illustrate the inefficiencies of the military system of management, it will prove profitable to take as an example one of the minor executives under the system, examine his duties, and see the type of man necessary to successfully carry them on. The experience that is gained from the study of this one type of executive can then be applied when considering the changing of the entire type of organization. The executive chosen for illustration will be the shop foreman, and the plant will be the diversified machine shop.

Under the military type of organization, the foreman is held responsible for the successful running of the entire shop, and when his duties are measured by the requirements of good management, it becomes apparent that these requirements are extremely difficult to fulfill under the conditions. The foreman under this system of organization must lay out the work for the whole shop, seeing that each piece of work goes in its proper

[1] "Shop Management," Frederick W. Taylor, Harper & Bros., p. 93.

order to the right machine, that there is a man at the machine to do the job when it gets there, and that he knows just what is to be done and how he is to do it. The foreman must see that the work is done correctly, is not slighted, and is done promptly. Meanwhile he must look well ahead, possibly a month or so, to determine what the demands on his shop will be at that time. He may have to provide more men to do the work, or he may have to endeavor to secure more work for the men to do. The disciplining of the men is entirely up to the foreman, as is all relationship between the firm and the men on the subject of wages. This last includes such matters as supervision of timekeeping, the fixing of piecework prices or day rates, and the readjustment of wages from time to time.

In order to have proper management it is essential that each member of an organization have a clearly defined task, the limits of which are well known. In other words, responsibility must be fixed, as we learned in our consideration of the fundamentals of organization. Furthermore, it is necessary that the limits of the task shall not be too broad. Evidently there are but few limits to the foreman's task in the present instance. It is unlikely that it is even clearly defined. Each day he must decide on the basis of his own judgment just what small part of the mass of duties in front of him it is most important for him to attend to. He does a fraction of the work for which he is responsible, leaving the balance of the work to gang bosses and workmen to do as they may see fit. It is only the exceptional foreman under the military system who delegates any specific portion of his duties. Most foremen have been opportunistic and from time to time have asked some of their subordinates to perform this or that portion of a given function for them in a specific instance or for a short space of time.

It is also essential, in order to have proper management, that the task be not only clearly defined, but that it be capable of accomplishment. The conditions in this case are such that it is clearly impossible for the foreman to do it all. Suppose the foreman does secure aid in his duties from his assistants, or from a gang boss who is in charge of some particular group of machines, such as lathes, planers, milling machines, etc. Each of these men is called upon to perform duties of as great a variety as the foreman himself. If it is difficult to get a foreman with the required large range of capabilities necessary to perform all the various tasks, how much more difficult is it to get subordinates who can qualify? The one help of the situation would be for the foreman to delegate a specific portion of his duties, but this he seldom can be prevailed upon to do.

Frederick W. Taylor has pointed out the qualities of a well-rounded man as the following: "Brains; education; special or technical knowledge, manual dexterity or strength; tact; energy; grit; honesty; judgment or common sense; good health." He points out that three of the

above qualities can be hired at any time for laborers' wages. If four of these qualities are added together it is necessary to secure a higher-priced man. The man combining five of these qualities becomes hard to find, and those with six, seven or eight are almost impossible to discover. Having this in mind, Mr. Taylor enumerates, as follows, the duties which a foreman or gang boss in charge of a group of lathes or planers is called upon to perform under the military system and the knowledge or qualities demanded of him on that basis.[1]

" First. He must be a good machinist—and this alone calls for years of special training, and limits the choice to a comparatively small class of men.

" Second. He must be able to read drawings readily, and have sufficient imagination to see the work in its finished state clearly before him. This calls for at least a certain amount of brains and education.

" Third. He must plan ahead and see that the right jigs, clamps, and appliances, as well as proper cutting tools, are on hand, and are used to set the work correctly in the machines and cut the metal at the right speed and feed. This calls for ability to concentrate the mind upon a multitude of small details, and take pains with little, uninteresting things.

" Fourth. He must see that each man keeps his machine clean and in good order. This calls for the example of a man who is naturally neat and orderly himself.

" Fifth. He must see that each man turns out work of the proper quality. This calls for the conservative judgment and honesty that are the qualities of a good inspector.

" Sixth. He must see that the men under him work steadily and fast. To accomplish this he should himself be a hustler, a man of energy, ready to pitch in and infuse life into his men by working faster than they do, and this quality is rarely combined with the painstaking care, the neatness and the conservative judgment demanded as the third, fourth and fifth requirements of a gang boss.

" Seventh. He must look ahead over the whole field of work and see that the parts go to the machines in their proper sequence, and that the right job gets to each machine.

" Eighth. He must, at least in a general way, supervise the time-keeping and fix the piecework rates. Both the seventh and eighth duties call for a certain amount of clerical work and ability, and this class of work is almost always repugnant to the man suited to active executive work, and difficult for him to do; and the rate-fixing alone requires the whole time and careful study of a man especially suited to its minute detail.

" Ninth. He must discipline the men under him, and readjust their

[1] "Shop Management," Frederick W. Taylor, Harper & Bros., pp. 96–98.

wages; and these duties call for judgment, tact and judicial fairness."

This enumeration of the duties of a gang boss by Dr. Taylor was the first real analysis of the military-system supervisor which had ever been made. It is at once clear when it is studied that the duties which the ordinary gang boss is called upon to perform would demand that he possess a large share of the nine attributes of the well-rounded man previously referred to. As Dr. Taylor pointed out, such a man would not be gang boss, but general superintendent.

Functional shop supervision. The solution to the problem lies in the fact that there is an abundance of men with four or five of the attributes and that different men possess different ones of the attributes. If the work of management could be so subdivided that the various positions could be filled with men of this caliber, the problem would be solved. This could be accomplished by substituting a new type of organization in the concern, namely, the "functional type." It has been seen that functional management consists in so dividing the work of supervision that each man below the general manager shall have as few separate functions to perform as possible. If feasible, the work of each man should be confined to the performance of one function, or at least functions requiring essentially the same attributes.

Under the military type of management the workmen are divided into groups which receive all their orders and instructions from one man, who may be termed the foreman or gang boss of the group. Under the functional system, as proposed by Dr. Taylor, each workman, instead of coming into direct contact with but one man, through whom he secured all his contact with the management, receives his daily orders from a group of specialized or "functional" foremen or supervisors, each of whom performs his own particular function. Dr. Taylor, in "Shop Management," set down the proper number of these functionalized foremen as eight, four of whom were engaged in general planning work, and thus were entirely removed from the shop and placed in a controlling department known as the planning room. We shall hear more concerning these men at a later date. Most of the planning and clerical work is absorbed by them. Four other foremen were actually in the shop, and we shall speak only of the duties of these, since we shall be able to secure in this way the complete significance of functional foremanship without touching on the subject of planning-room operation, an entirely separate matter. It should be understood that this division of functions among the foremen is based on the needs of a machine shop. In other industries, another division might be necessary.

The four bosses in the shop personally help the men in their work, each boss helping in his own particular line or function only. Several of

these bosses come into contact with each man only once or twice each day, and then for a few minutes perhaps, while the others are with the men constantly, and help each man frequently. The functions of one or two of these bosses require them to come into contact with each workman for such a short period of time each day that in small plants they are able to perform their duties for the entire shop. Other bosses are called upon to help their men so completely and so often that each boss can perform his function for but a few men. Thus there are several bosses of this particular type in the shop, all performing the same function of supervision over a different group of men. There is no specific group of men with four functional bosses over them, but rather a number of workmen falling into varying groups for supervision purposes depending on the type of supervision, and the amount of this type that is necessary. This is ordinarily known as the Taylor type of functional shop supervision.

The following is a brief description of the duties of the four types of functional bosses in the shop; namely, the gang bosses, speed bosses, inspectors, and repair bosses.

The gang boss has charge of the preparation of all work up to the time that the piece is set in the machine. It is his duty to follow up the plans of the planning men and to furnish all the jigs, templets, sling chains and other necessary adjuncts for coming operations. The gang boss must show his men how to set their work in their machines in the quickest time, and see that they do it. He is responsible for the work being accurately and quickly set, and should be not only able but willing to show the men how to set the work in proper time. This man has nothing whatsoever to do with the running of the machines, and his work is completed as regards a particular operation when the work is set up in the machine. Furthermore, if there be a planning department, though he will advise with it, in a sense he will be mainly executing its orders.

The speed boss must see that the proper cutting tools are used for each piece of work, that the cuts are started in the right part of the piece, and that the best speeds and feeds and depth of cut are used. His work begins only after the piece is set up in the machine, and ends when the actual machining ends. The speed boss must not only advise his men how best to do the work, but he must see that they do it in the quickest time, and that they use the proper speeds of the machine and so set their tool that they secure the proper depth of cut. He may be called upon, by the exigencies of a situation, to demonstrate that the work can be done in the specified time, by doing it himself in the presence of his men. It should be carefully observed that the words "speed boss," refer to supervision over proper speed and not to an attempt to "speed up" the workman without regard to his capacities or the time in which the operation should be performed. He has recently been termed an "instructor"

rather than "speed boss." He is a teacher of method to the men under him, not a slave-driver.

The inspector is the third of the shop bosses, and is responsible for the quality of the work. Both the workman and the speed bosses must see that the completed work is up to specifications in order that it may be passed for quality by the inspector. The inspector can, of course, best qualify for his tasks if he is complete master of the machines himself, and can personally do the work both quickly and well. Under such circumstances his rejections will be taken with better grace by both the workmen and the other bosses in the shop. The inspector always sees that the first piece made up is of the proper standard in dimensions, fit and finish. He also makes further inspection from time to time as the needs of the job may dictate, to see that the standard is maintained. An over-zealous speed boss, in his desire for large output, may allow the workman to impair the quality of the work done by exceeding the tolerance limits, and therefore the inspector becomes the quality man, as contrasted to the speed boss who is a quantity man primarily.

The repair boss is the fourth and last of the shop foremen. The duties of the repair boss include seeing that the workman maintains his machine and work-place in proper working condition. This includes the cleaning of the machine, keeping it free from rust and scratches, the proper oiling of the machine, the preservation of the proper standards which have been set up for the auxiliary equipment pertaining to the machine, such as belts, counter-shafts, and clutches. The maintenance of the cleanliness of the floor around the machine is also under the supervision of the repair boss.[1]

Advantages of functional foremanship. The most immediate gain from this system of functional foremanship, even if the functional idea is not extended to any other portions of the organization, is that it becomes possible, in a comparatively short space of time, to train bosses who can really perform the functions demanded of them. A glance at the duties of the functional foreman will show that he is not required to have over four or five of the nine qualities of the well-rounded man. Efficient functional foremen have been made from raw recruits in a period of eighteen months. It thus becomes possible to equip a new company just starting up with the proper shop officers in a reasonable period. Another advantage is that with more bosses, each of whom actually gets an opportunity to supervise the men under him along the particular function over which he has control, the workmen need not be of such high caliber as they are required to be under the military system, involving as the latter does, the impossibility of adequate supervision.

[1] Much of the material in the preceding paragraphs is adapted, by permission, from "Shop Management," by Frederick W. Taylor (Harper & Bros.).

Can a workman serve two masters? There is a very deep-rooted conviction in the minds of many industrial managers that no workman can work under two bosses at the same time, and the idea of functional foremanship had slow growth as contrasted to the other modern management devices on this account. Mr. Wilfred Lewis, President of The Tabor Manufacturing Company has stated, "The old notion that a man cannot serve two masters or take orders from more than one superior is denied by the new philosophy which makes it possible for the workman to have as many bosses as there are functions to be performed. There is no conflict of authority unless the functions overlap, and even such conflict as may arise is salutary and to the interest of the company." Mr. H. K. Hathaway has similarly pointed out that there is no conflict if one boss says, "Go East," the next, "Take this equipment," and the next, "Proceed at such and such a rate." On the other hand, it will be found that in organization to-day radical changes have been made from the concept of functional organization just mentioned. This has been largely in the creation of functionalized departments working through one foreman. The influence of those men who feel that a workman can properly serve only one boss has mainly prevailed. They are correct in the idea that there can be over-functionalization.

When functional foremanship is introduced into a large shop it is desirable that all the bosses who are performing the same function should have their own foreman over them. Thus, there is a general speed foreman who has charge of all the speed bosses, a chief inspector, who has charge of all the inspectors, etc. The functions of an over-foreman are twofold. The first part of his work is to teach each of the foremen under him the exact nature of his duties, the second is to smooth out the difficulties which arise between the different types of bosses, who in turn directly help the men. The speed boss, for instance, always takes charge of the workman after the gang boss on any particular job. In this way their respective duties come into contact for a short time, and there is sure to be more or less friction between the two. If two of these bosses meet a difficulty which they cannot settle, they send for their respective over-foremen, who are usually able to straighten it out. In case the latter are unable to agree, the case is referred by them to the next higher authority, who may be the assistant superintendent. This reference of disputes is a good example of the operation of the exception principle of management. It also indicates the way in which departmentalization rather than functionalization was begun.

The idea of functional foremanship, as promulgated by Taylor, was not accepted at its full value by the business community, largely because of the fact, already referred to, that it has been the constant idea that one man could not serve two bosses. At this time, it is important to

point out that although Taylor used the example of the foreman in the metal-cutting shop to bring home his point, the idea of functional management, new with him, had a far broader significance than merely in the matter of foremanship. It was in some of the other phases of management, in some of the other levels of organization, that the seed of the idea was destined to spread further than it did in the level of foremanship. Wide-awake executives were quick to realize that Taylor's indictment of the military system was a true bill. They saw that what Taylor had said of the qualifications necessary to run a supervisory job under the military system was correct, that the qualities which were demanded of men under that system were so numerous that but few men were possessed of them, and that therefore, some change from the strictly military system of organization was essential if their business organization was to reach the maximum effectiveness. Recent years have witnessed sweeping changes from the strictly military organization system of twenty years ago. These changes, largely stimulated by Taylor's indictment of the military system, drawn up to serve as the groundwork for his functional scheme, are of varied sorts. They will be reviewed in following pages.

The development of the committee idea in organization. Proper regard for the fundamentals of organization will enable the executive to lay out the structure, or framework of an extremely workable organization of the type he desires. However, at best he must paint in these outlines with a broad brush, and there will probably remain many little hidden defects, many places where there will occur friction of one kind or another, due to mal-adjustment in the various portions of the organization that he has built up. The framework must have built upon it the superstructure of every-day harmony that can only be secured by the whole-hearted support of every portion of the organization that has been outlined. There must be found some lubricant to make the parts of the organization work with each other and dovetail into one another without the least semblance of friction. Only by reaching such an ideal will there be secured an organization that truly functions smoothly.

Sometimes the necessary smoothness of operation can be secured through the dominant personality of the builder of the organization or his aides in their exercise of executive control. But if the parts of the organization can be gotten to automatically lubricate themselves in their inter-relationships and common business dealings, the strain on the executives, from the general manager to the minor executives, will be relieved to just that extent.

The greatest fault in creating a new, revising an old, or operating a continuing organization has frequently been the failure of the general executives to give proper regard to securing the co-operation of those foremen and minor executives on whom success or failure of the organiza-

tion will ultimately depend. Methods must be suited to the circumstances of the particular business or department. The sympathetic support of all must be secured for the proper operation of the organization, particularly if there are any changes to be made in methods of organization, system, or shop processes. The most thorough and effective system in existence will not bring a large degree of success, even if built up on the most perfect observance of the fundamentals of organization, unless it be supported by minor executives and workmen. Thousands of dollars have been wasted by large industrial concerns and small ones in attempting reorganization where this factor has not been taken into account.

The co-operation of the men forming the organization is essential. To enlist the co-operation of these men, who in the last analysis are those on whom the success of operation depends, is, in its larger elements, not a really difficult task. They must have some share in forming the plans, some share in devising the methods of management. They must be made to feel that the methods being utilized are really their own. They must be consulted frequently and thoroughly concerning difficulties, and encouraged to suggest ways of overcoming them. They must be led to tell ahead of time those rocks on which the ship of management is likely to founder, and to point out the shoal waters where it must run slowly. It is their knowledge, their experience, their information about the detail, which must be brought to the aid of the developers of management methods. If some comprehensive plan can be worked out that will insure this result, and if it is put into effect, the difficulties are likely not to appear at all, or to be soon diminished and quickly disappear.

All plans dealing with organization, reorganization, or operation of a business, which are thought out by the heads of the enterprise must necessarily be constructed with three cardinal ideas of co-operation in mind:

1. The executive must keep in mind this: "What would I think if I were in the other fellow's place? What plans would be most likely to secure my support, develop my latent ability, and bring out the best that is in me for the support of the enterprise?" It is not meant by this that it is necessary in constructing a new organization to keep this idea as the controlling factor in the construction. But this factor must be taken into account and given the weight that it deserves. It is a question of the knowledge, experience and limitations of the other fellow, and these are vital factors in the success of an organization, for if they are not reckoned with, they are more than likely to limit the success.

2. The plans must be developed along the lines of complete co-ordination. The fact must be recognized that generally the joint advice of a group of men conversant with a subject is immeasurably superior to the thoughts of one man, or any plan developed from one man's brain. The

only possible method of developing a proper group spirit is by getting men together. Their jealousies and their distrust of each other can be eliminated only by bringing them into close contact with one another and by steering them in a tactful manner. The spirit of helping each other for the good of the enterprise can best be brought forth by bringing men together in conference. Perhaps the results will be but gradual, but if proper attention is paid to the methods of cultivation they will be certain and not extremely difficult to secure.

3. From an administrative standpoint, all persons interested in a given phase of management must have knowledge concerning factors in the business which influence the daily conduct of their jobs. The larger the business the more need for definite co-operation on this point.

A method that has proved of enormous success in attaining these ideas is the use of committees as aids to management. The Committee Idea recognizes the human factor, fosters the spirit of co-operation, implants the new ideas of organization and its fundamentals into the minds of all members of the organization, and gives everyone the necessary contact to properly perform his tasks. The Committee Idea, through organized committees, secures, on troublesome problems, the advice of those best qualified to aid. It stimulates these men to give the company the best that is in them. These standing committees solve routine problems of operation, but also learn of and advise concerning policy and organization development.

Up to this point consideration has been given to the need for co-operation in organization matters and to the committee system as a means of developing this co-operation. Nothing has as yet been said regarding the structure of the committees. In the first place, it should be carefully observed that the committees being spoken of are of a purely advisory character. They usually suggest courses of action to the chairman, aiding him in reaching decisions. He may accept or reject their decisions, but normally, if the committee work is properly developed, matters will be thrashed out there and the decision will become practically final.

Formation and duties of committees. In each organization, the problems affecting the men who form the committees would vary so as to make hard-and-fast rules for the organization of these committees very largely out of the question. In most cases the factory superintendent would be chairman of the most important factory committee. Those men in the other phases of the organization who hold similar relationship to their portions of the organization should head their committees. In large enterprises, where the superintendent would naturally have several assistants, these may be the heads of the less important committees, though it has been found in some cases that the work of the committees frequently renders the assistant himself unnecessary. From four to seven

men have been found to form the ideal committee in size. A smaller number of men is likely not to provide for sufficient discussion, while a larger number is likely to prove unwieldy.

The plant advisory committee. A tentative personnel for the plant advisory committee would include the designer of product; the head of the sales department, or the member of the production organization whose function is to effect liaison with the sales organization; the head of the cost department; and possibly two or three foremen of the most important departments. There should be a secretary, not only to preserve information concerning actions taken, but to straighten out many difficulties between meetings, and have matters for the committee's attention in such shape that it will be possible to get them out of the way in minimum time at the meetings.

The work of the committee, generally speaking, can well include:

1. Plans to change the product, including a consideration of new methods of design, or new items to be marketed. The interplay of sales and production factors must here be considered.

2. Progress that has been made on changes already begun. This is important, for unless it is considered it will be found that new ideas which have been decided upon and already partially put into effect can be totally forgotten in the press of daily routine.

3. Consideration of methods of cost reduction. Reports by committee members upon economies, decided upon in previous meetings, and assigned to them to put into effect, might be included. In this connection, when work of a specific department is taken up, it is possible and advisable to have the foreman in charge of that department in the committee meeting, whether he be regularly a member of the committee or not.

4. A discussion of routine operation, the status of orders, causes of hold-ups, progress of manufacturing programs, etc.

The number of meetings of this main committee or any other committee are, of course, always to be determined by the needs of the business. However, there probably should be a minimum of one a week, since policy control of each phase of the business should certainly be discussed at least as frequently as that. The maintenance of the committee idea necessitates that the members of the committees look upon the meetings as of real importance and place the meetings ahead of all other pressing engagements which may occur. To secure and maintain this attitude on the part of the committee members, it is necessary that meetings be not too frequent and that only vital topics pertaining to important phases of the operation of the business or department be considered in them.

Departmental committees. Departmental committees, which correlate the work of particular departments of the concern, would operate along essentially the same lines as the main committee. It is probable

that their meetings can be held less frequently. It is very advisable to include on these departmental committees some of the subexecutives, particularly in large organizations. This enables these subexecutives to definitely learn about the fundamental policies of the enterprise and, therefore, to be able better to interpret these policies to the rank and file of the concern. This is an important phase of committee system development, inasmuch as misinterpretation of the real policy of the firm is often the underlying cause of many labor disputes. Furthermore, a full understanding of underlying policies of the enterprise makes certain that everyone is pulling together in exactly the same direction.

The development of the committee idea, and particularly the inclusion of the subexecutives in it, undoubtedly has a good effect on the workman and other privates in the organization. The subexecutive's position becomes a more attractive one to strive for, since it is now in on the "management" of the company. Furthermore, it is soon found that under the operation of the committee idea, it is unusual for department heads to pick unfit men for subexecutives. This acts as a further incentive to the worker.

Foremen's meetings. Another phase of the development of the committee idea which has within recent years proved to be of great importance in factory operation has been the "foremen's meeting," held about once a month. It is necessary to guard against having one man at too many meetings in a week, however, lest his time be taken up entirely with the discussion of what he is to do, and what he has done, and he be not given the opportunity to really do anything. At this foremen's meeting there should be present the foremen and assistant foremen, the members of the Plant Advisory Committee, including the superintendent, and if possible, one of the higher officials of the company.

At these meetings operation problems are the main basis of discussion. Employment and general labor matters have also formed an important subject in recent years. Frequently the labor policy of the enterprise can be so shaped at the foremen's meetings as to eliminate danger of labor troubles.

If the departments in a concern are not too numerous each foreman should make a statement concerning the status of his own department, and a statement as to whether any other department is causing him or his department any difficulty of any character. As the foremen know that they cannot deceive the other foremen before them, each of whom will naturally defend the work of his own department, such a system leads to the discovery of many causes of retarding production. The discussion which ensues leads to definite plans for the overcoming of these difficulties.

The full development of a committee idea, such as has been outlined, insures above all things that the company policy affecting employees.

which the general management desires carried out, will be carried out. This policy may be warped and changed in the meetings themselves, as the needs which exist are seen, but, once decided on, the policy will be carried through. The fair-minded policy of the management is frequently twisted out of shape, so that the management can hardly recognize it by the time it reaches the workmen. The committee idea practically insures that the labor policy of the company will be correctly interpreted all the way down the line. On the other hand, this system should in no way be confused with various systems that provide for the worker having some actual voice in the management of the concern. The primary purpose of the committee idea is not to do this, but merely to make for the smooth working of the organization. The idea of giving the employee a voice in management will be discussed in Chapter XXXI.

The success of the committee idea in finding the " strong man " of the constructive type in the organization is truly remarkable. It cannot be equaled as a discoverer or developer of " strong men." The ideas of these men must by necessity force themselves to the fore and become an integral part of the policy-direction of the enterprise. The general practical benefits of the idea are enormous. Improvements are rushed to completion, instead of dragging along. After the system has once been installed, there is little flare-back because someone " wasn't asked."

CHAPTER VI

ORGANIZATION TO-DAY

The modern industrial enterprise in which the organization has been consciously and intelligently developed is usually found with a plan of organization that has been molded to fit its own peculiar needs. We have already discovered that it is necessary that an organization be developed with due consideration of certain fundamentals, with due thought to the type that is to be utilized, and with proper consideration to certain features peculiar to the individual business, as, for instance, size, product being manufactured, or even location. Thus, although the basic ideas actuating the organization work of several managers may be similar, each organization will ordinarily be built up to fit the peculiar needs and to approach the particular ideals of those in control of the enterprise. Seldom will it be found that the organization charts of two successful businesses will be the same, although study of them may reveal that the ideas of those developing the organizations were similar. Proper consideration of all factors affecting organization, as, for instance, the aim of the enterprise, consideration of the personal equation, the size of the business, will demand that the organizations of two different businesses be constructed along divergent lines.

The line and staff type of organization. In the development of organization work it is but seldom that a successful concern is found which has adhered strictly to a particular type of organization. The military and functional types have, in the main, given way to the line and staff type, which develops the best possibilities of both and does not have the faults of either. To this has been added, ordinarily, some consideration of the committee idea, with the result that the modern organization is usually found to be built up with all of these ideas in mind. In fact, instead of finding to-day the strictly military organization, it is usual to find only the influence of this type in the thought that often authority must flow directly. Likewise, instead of finding the functional type, it is usual only to find the effect of its influence in functional departments. Skilled specialists are found heading departments which look after particular phases of the business, reducing the work of the line members of the organization, and adding much skilled, technical knowledge in operation.

The development of the " line and staff " type of organization has for its foundation the joining of the functional idea with the direct " line " flow of authority provided for in the military type. The developments following the pronouncement of Taylor's functional foremanship idea hastened the demise of the strictly military type of organization, which had, in fact, already begun. Although functional foremanship in the exact form developed by Taylor has never been greatly utilized in the industrial community, nevertheless it has served to shape the broad outlines of most organizations, in manufacturing and out, which are found to-day. There are some plants which definitely have functional foremanship as a part of their organization and have found success in using it. There are other plants which have tried it and definitely given it up. But most plants have developed functional " supervisors " instead of " foremen," or have developed the functional department, of which the supervisor is in charge. These functional departments guide and to some extent control the foreman. In their development it has been definitely kept in mind that the foreman is intelligent, in fact that he is the backbone of the operating organization of any plant. The organization is so constructed that the foreman can retain his one-man control over the personnel under him, and at the same time can have his direct responsibilities reduced to a point within the range of accomplishment. The foreman's primary duty is leadership and under this plan of organization he may better perform this function. The specialized or functionalized departments are staff departments which give technical operating information to those in direct charge of the workmen.

Thus the development of the " line and staff " idea utilizes the necessary flow of authority from top to bottom, as in the case of the military type, with side-eddies of authority flowing out from the main stream at different points along the lines of supervision, in the form of functional or staff departments. These staff departments have not only fixed responsibilities, but definite supervision over others in the organization. Directions from these departments must be observed by other co-ordinate departments and by subordinates, in the same manner as if the orders had come from the head of the organization or from those in direct line control. The authority of the staff department is supreme in the particular field of its function, except as it may be modified through conference or change in responsibilities delegated to it. In cases of conflict of authority, decision is made by the supervisor of the staff departments in question; or, if there be a working committee organization, possibly by representatives of these departments in conference, with the supervisor present. The committees which are found in the line and staff organizations are, of course, only advisory in character. It should again be emphasized that they may be placed at any point in the organization and are com-

posed of men or women whose other duties are clearly defined in addition to their duties as members of the committee.

Although the discussion of the line and staff idea has been confined to the factory end of business organization, what has been said should be read and interpreted as applying to all phases of the business. The direct control of line members of an organization and the staff control of experts or departments is to-day found in every phase of business enterprise. As nearly as can be decided, the idea was first developed in connection with plant operation, but it has spread into every other portion of manufacturing businesses, and all other types of businesses. There are now effective organizations in all fields of endeavor which have been developed along line and staff principles. To clarify the distinction between a line man and a staff man, or a line department and a staff department, a basis for discriminating may be given. A line man is one whose work deals with more than one phase of his division of the business, and who has " productive " workers under him. A staff man usually deals with but one particular phase of the business, or, if his work be of general character, " productive " workers will not be found directly under him.

Organization charts. Organizations have their photographs taken through the preparation of organization charts. These set down on paper the structure of the organization, by indicating positions or departments, and then showing the lines of supervision between them, as well as frequently definitely stating under each position or department the responsibilities attaching thereto. As shall be seen, organization charts, like other photographs, are not wholly satisfactory, inasmuch as many little details and inter-relationships of live, operating organizations cannot be properly pictured on a chart. But the most satisfactory way of studying modern organization development is through the utilization of a typical organization chart. In studying such a chart it is well to remember that the titles given individuals or departments in various enterprises vary with the whims of the organizer, even though the duties performed be essentially similar. Therefore it is well always to make sure that seeming great differences between two organizations are not merely differences between the titles of the individuals or departments in question. The attached " typical " chart (Fig. 4), which will be used as a basis of this discussion, will indicate the organization of a large enterprise, because it is in such a concern that the various functions are most clearly separated and defined. It should be clearly understood that in small concerns, although the same functions would exist, many duties would have to be combined.

The typical organization. All organizations have at the top the owner of the business. This may be either an individual, a partnership, or a corporation composed of a group of stockholders. In studying organi-

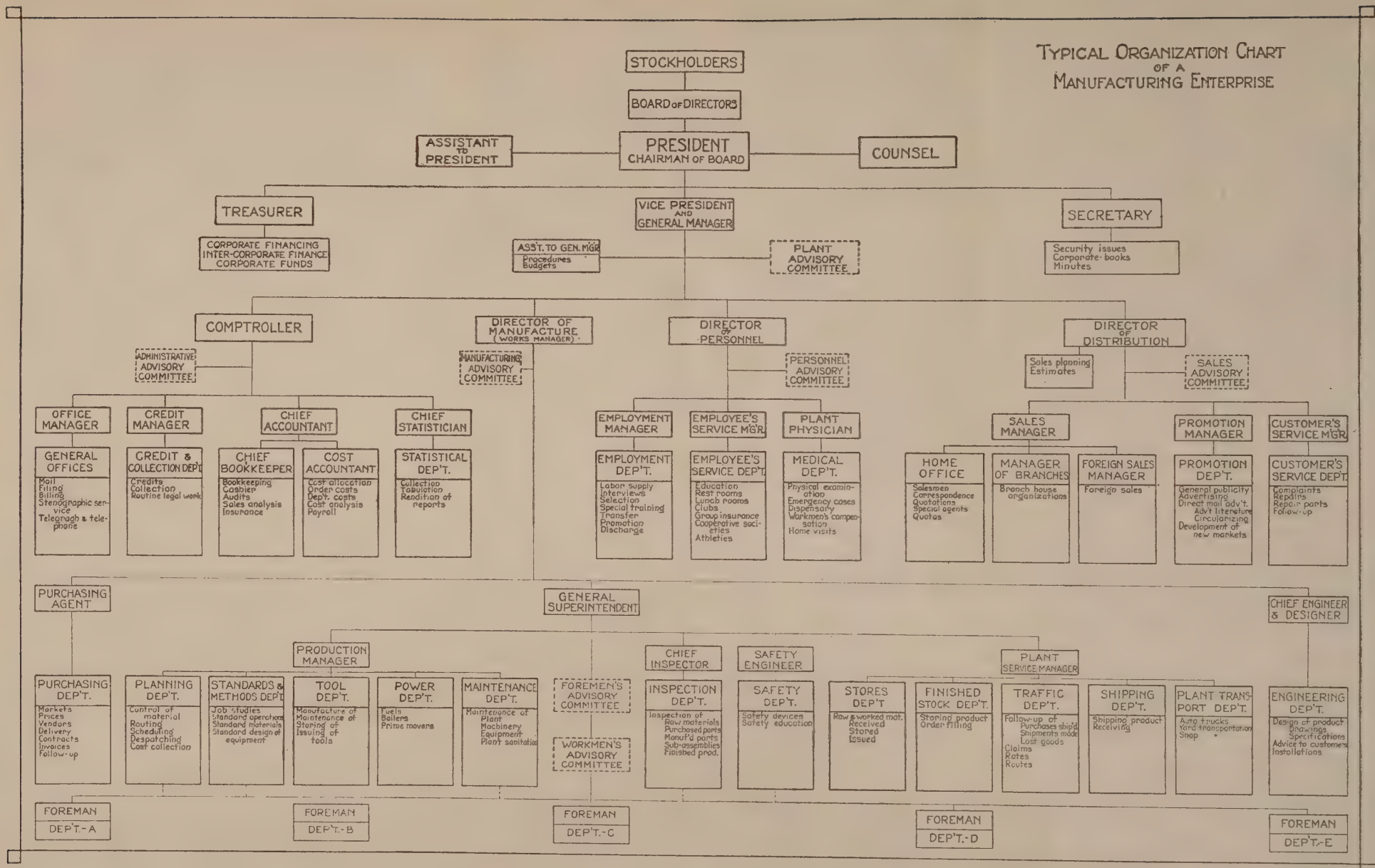


FIG. 4.

To face page 72.

zation it will be best to consider the most complex of these, namely, a business owned by stockholders. In such a business the distinction between the corporate or ownership activities and the operating activities is ordinarily clear-cut. The stockholders usually select, through their elected board of directors, a president, who is actively engaged in the direction of the corporate policy of the business. The president supervises all the truly corporate activities of the business, but ordinarily does not supervise the operating activities. In carrying on his work, the president is assisted by duly selected officers, having control of certain parts of the corporate work, such as the treasurer, in charge of company funds and financial policy, and the secretary, in charge of corporate records and stock transfer. The functions of the treasurer and secretary should not be confused with somewhat similar ones incident to the daily operation of the business. In the type of organization being described, these latter functions would be controlled by executives who would be under the control of the general manager, who has charge of and is responsible through the president to the board of directors for the operation of the business. In many smaller concerns, there is no president, but a general manager who reports directly to the board of directors, or the president and general manager may be the same person. In such cases the treasurer is in charge of operating work as well as corporate work. Thus routine accounting and record work would be under the control of the treasurer. It is usual to have the secretary of the company keep only the corporate records, regardless of the organization. However, in the second case, he would naturally report to the general manager.

Principal divisions of the enterprise. Under the general manager, or operating head, of the enterprise, there is an immediate split into divisions of operation, functional in form. There is, for instance, the comptroller, who deals with all office, accounting, and record operation; the manager or director of manufacture who has under his control all matters relating to plant operation and the manufacture of product; the director or manager of distribution, who controls sales; and, in many modern organizations, the director of industrial relations, who deals with all matters concerning personnel. If there be any phase of the committee idea installed, these heads of divisions will usually, together with a few other key men, form the Plant Advisory Committee. They, in turn, will be assisted in the formulation of policy for and operation of their own divisions, by advisory committees. In this development of the main operating organization it will be noted that there are but few main divisions, which means that there are but few persons reporting directly to the general manager. This is an essential of good organization. It gives the general manager an opportunity for real policy development, which he does not have if he has a large number of persons reporting directly to him. A

frequent cause of failure of industrial organizations to operate properly lies in having too many persons reporting directly to the general manager.

A necessity which is often overlooked is that of sometimes creating special temporary divisions for carrying on some special or unusual work. Examples of this would be found in the creation of a "new building" division, in case a new structure were being erected for the business, which division would have supervision over construction and movement into the new building, or the creation of a "Government work" division when Government contracts are held by the business. The demands of Government work, for instance, Government accounting, sometimes make it advisable to erect a complete new division in the organization, if there be much Government work to be done, rather than to subordinate this phase of operation to the director of manufacture or chief of some other principal division of the business.

The comptroller's division. The comptroller (or treasurer under the second type of organization) has under him certain staff heads, each controlling the operation of one phase of the office work. These men are the office manager, in charge of the general office operation; the credit manager, in charge of the granting of credits and the collection of accounts receivable; the chief accountant; and the chief statistician. A separate section has been set up under the chief accountant to handle costs. This is a particularly important phase of manufacturing accounting. The collection of cost information is usually regarded as a production function and is placed in the hands of the planning department, under the production manager. In the organization, as outlined, the chief accountant might have one or two clerks who worked on the general books of the business, reporting directly to him. There must of necessity be some tie-up between the distribution division and the credit man under the comptroller. Such a tie-up can well be secured through the committee which advises the comptroller, by placing on the committee a representative of the sales department.

The sales division. The work of the director of distribution falls under several heads, which in large organizations are each in charge of a competent executive. Thus, there are the functions of promotion, including advertising and the development of new markets; sales, and service after sales. The organization of the office of the director of distribution will be found to vary considerably with the selling problems involved in different types of enterprises. For instance, the creation of branch sales houses immediately creates problems concerning the relationship of the heads of these houses, whether they should report through the sales manager, or directly to the director of distribution through a new "branch house section," or possibly report directly to the general manager through a new "branch house division."

The personnel division. The work of the director of personnel has been largely increased both in amount and in responsibility within recent years. Since there will be considerable attention devoted to this phase of industrial organization later, the work of this division will only be briefly outlined at this time. Its functions are clearly indicated upon the chart. In its full development it has jurisdiction over all matters pertaining to the personnel of the organization, be that personnel in the comptroller's office, in the sales department, or in the manufacturing division.

The manufacturing division. Directly under the director of manufacture, or "works manager," as he is frequently known, there is a line man, the superintendent, who with the aid of advisory committees, directly controls the operations of the foremen of the various departments of the factory. The foremen are directly over the workmen, possibly through job bosses, or assistant foremen, who may be in control of certain portions of their department. There is thus direct line control or authority from the director of manufacture to the workman. It is the establishment of this authority which promotes discipline, and allows for the quick and accurate working of the organization.

The staff portion of the manufacturing organization is partially to be found under the direct supervision of the director of manufacture and partially under the direct supervision of the superintendent. The manufacturing division affords the best opportunity to observe the effect of the functional idea in the development of the staff portion of the "line and staff" organization. There is, first, the purchasing agent, in charge of the purchasing department. Under older organization types this function was ordinarily placed on an equal plane with that of the chief of manufacture. In modern organizations, he is sometimes found in the same position. Making purchasing a main division of the business may be due to consideration of the personal equation, but it is generally due to the importance of purchasing in the particular business. The purchasing agent, in any business, must be closely in touch with markets and prices, and must be closely associated, in his daily operations, with the sales and financial ends of the enterprise. In some businesses this is not of paramount importance and the purchasing agent can safely be placed in the position shown on the chart. In such cases, policy control with respect to purchases will remain in the hands of the general manager. However, in businesses where much of the profit or loss is dependent on the operations of the purchasing department, it must be looked upon as a main division of the business and a broad-gauged executive placed in charge. Such businesses include those of wide and rapid fluctuations of market price, or those in which the manufacturing operations are relatively simple and do not add greatly to the value of the product, as in cotton mercerizing.

Where these conditions do not exist, better results are ordinarily secured by placing the purchasing agent as indicated on the chart. Such correlation with other departments as is necessary can be secured through placing him on one or more advisory committees, and still leave him under the control of the manufacturing manager. The value of placing the purchasing agent under the control of the director of manufacture lies in the possibility thereby secured of correlating his functions with those of the production manager, inspector, and chief engineer, whose duties will next be described. The work of each of these men is closely bound up with the operations of the purchasing agent.

The chief engineer, or head designer, has charge of the design of product and related subjects. He is thus particularly qualified to, and it is necessary that he should, sit on several of the important committees, as his work affects nearly all phases of the business. He is generally a member of the Manufacturing Advisory Committee, and frequently he may be found on the Plant Advisory Committee. It is ordinarily a mistake to make the engineering or design department a separate division of the business, reporting directly to the general manager. This tends to lay too much emphasis on changes of design of product, with the result that both sales and production departments are hampered in their operation. However, there are some businesses, such as clothing manufacture, where the importance of the designer is great, and in such cases consideration may well be given to whether or not he should head a separate division reporting directly to the general manager.

Under the superintendent in the factory organization are found the members of the staff departments, who deal with particular functions of plant operation. The production manager has charge of those features which deal with aiding smooth flow of production. The chief inspector has charge of quality of production; the safety engineer has charge of the safety work; the plant service manager has charge of those functions which primarily assist the other departments that deal with production to function smoothly. Under the production manager is the planning department, the standards and methods department, the tool department, the power department, and the maintenance department.

Complete discussion of the functions of these various staff production departments will be reserved for consideration at later times, as each department's operation is fully considered. Nevertheless, a brief statement at this time is desirable. The planning department has complete jurisdiction over all the planning functions handled by the foremen under a strictly military organization, and in addition its development has caused the creation of certain new functions, as enumerated. The standards and methods department is interested in developing and explaining how the work should be done, in order that the planning department may have a

basis on which to plan, and the foreman on which to direct. It also provides the inspectors with a basis on which to check the work. Careful study of the duties of this department will indicate that here is the modern development of Taylor's " speed boss," with certain of the functions of the latter, such as instruction, left in the hands of the foreman. It is this department which has the most active daily interest in the substitution of science for rule-of-thumb methods in getting out production. The items listed as duties of this department are all portions of this phase of work. The tool department insures that all tools, of whatever character, necessary to production, are ready at the time needed and in proper condition. Thus maintenance of tools is part of the work of the tool department rather than the maintenance department. The power department has charge of the generation and transmission of power throughout the factory. The maintenance department has charge of the maintenance of plant, machinery and equipment and is the logical outgrowth and development of the " repair boss " under the original scheme of functionalized shop supervision.

The functionalized inspection department, under the chief inspector, is the quality department of the production organization, and although under the superintendent, is distinct from the quantity divisions of the organization as represented by the group under the production manager and the foremen of the various departments. It is exceptionally desirable to have different men working for quantity and quality. At the same time their work must be correlated under one head. In cases where the product is one with the exceptionally high quality requirements, the inspection department may not report to the superintendent, but directly to the works manager or director of manufacture. The chief inspector and his department deal with raw materials, partly finished and finished product. All quality work which relates to production is under their supervision. This department is readily recognized as having essentially the same functions as the original " inspector " of the functionalized foremanship scheme.

The safety engineer has complete charge of all safety work in the factory and particularly in dangerous trades. His position is one of great importance. As a matter of fact, in the most dangerous trades he might become a man of such importance as to be called director of safety and be one of the men immediately under the general manager. There is also the possibility of the location of this function under the control of the director of personnel.

The plant service manager has charge of the stores department, finished stock department, traffic department, shipping department, and plant transport department. In order to be able to control the planning elements of production, it is essential for the production manager to have

close contact with the plant service manager and the operation of the stores department. He must know what material is available for manufacture, so that he may take steps through the purchasing agent to have the necessary material ready at all times. The relations of the production manager's group of departments and particularly the planning department, to the stores department are so close that it may logically be said that stores, and for the same reason, plant transport as well, should be under the production manager. They are to be found there in many plants. The work of the other departments under the plant service manager is self-explanatory, except that it will be noted that the follow-up of purchases shipped and of finished goods shipped is left with this group rather than with the purchasing and sales departments respectively. Follow-up work of this nature may thus be centralized and correlated with the production program. However, this is an excellent example of the type of work in which the personal equation must be taken into account when developing lines of supervision and fixing responsibilities. Given the proper type of purchasing agent or director of distribution, these tasks might easily be split between them.

The organization described and illustrated on the attached chart is only intended to be typical. Modifications from it must be made in the case of small concerns, and modifications and amplifications should be made in order to adapt it to particular industries and particular plants. In a general way, however, it represents the best present-day thought on organization of manufacturing enterprises.

Although organizations, as found to-day, can best be discussed from a typical organization chart, as in the preceding paragraphs, nevertheless all industrial organizations are not built up along the lines discussed, and modifications and amplifications must be made in particular cases to fit particular industries or particular plant conditions, to such an extent that the organization charts of such plants are far different in character from the one just described. It will be well to briefly consider the organization charts of several typical enterprises with these facts in mind.

A typical military organization. The organization chart of the Oliver Machinery Company, Grand Rapids, Michigan (Fig. 5), indicates that this company has retained the military type of organization to an extent which makes it typical of those plants which are to-day organized mainly on the military basis. It will be noted that in this development of the military type of organization there is, nevertheless, some slight functional development under the works manager. It is practically impossible under competitive conditions existing to-day to run a plant of any size on a strictly military plan. On the other hand, the basic idea of organization may be either military or line and staff. In the case of this company it is military.

An organization chart from a large plant. The organization chart of the operating division of the American Rolling Mill Company, of Middletown, Ohio (Fig. 6), indicates the organization development at a very large plant. This chart is but an elaboration of a portion of the main organization chart of the company, and the various functions and departments shown on this chart, in the main, have organization charts of their own, as indicated by the reference numbers beside the name of the function or department. An interesting feature of this chart is the way in which it has been drawn up so as to make functions, such as operations, engineering, and inspection more important than positions, such as general superintendent, chief engineer, and chief inspector. The line and staff character

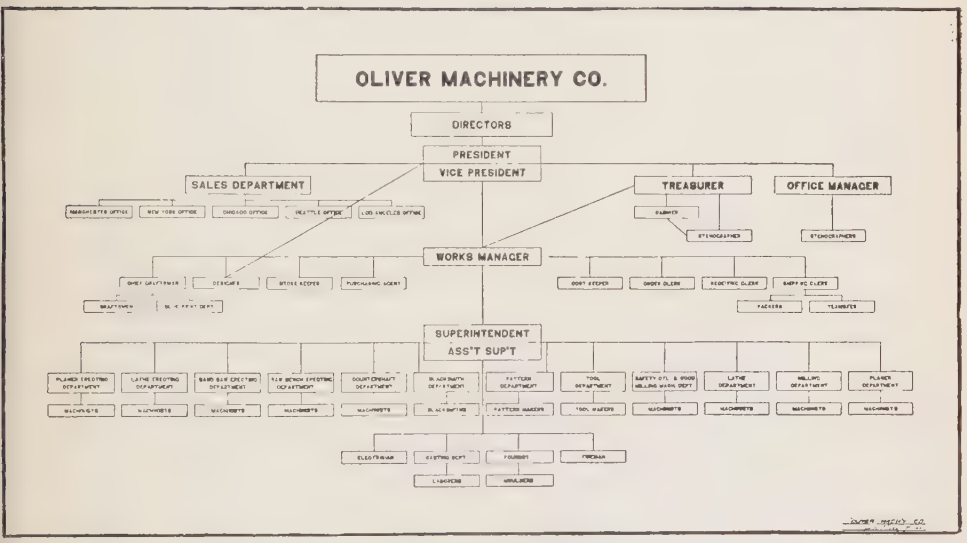


Fig. 5.

of this organization will be clearly evident if the functions of the various individuals indicated are carefully studied.

An organization chart which illustrates necessary changes with the type of business. The organization chart of the Dutchess Manufacturing Company, of Poughkeepsie, N. Y. (Fig. 7), a clothing factory, is particularly interesting because it indicates clearly the typical changes which can and must be made from the organization structure in the typical organization chart to meet particular operating conditions in a given business. It should be studied from the point of view of changes in major divisions of the business made necessary because of the type of business, and from the standpoint of representation on the chart of functions rather than individuals. Thus several individuals' names appear

several times under different functions of the business. This chart shows extremely well a way of indicating the authority not only of advisory committees, such as have been previously discussed, but of committees having the nature of works councils, which have jurisdiction over wages,

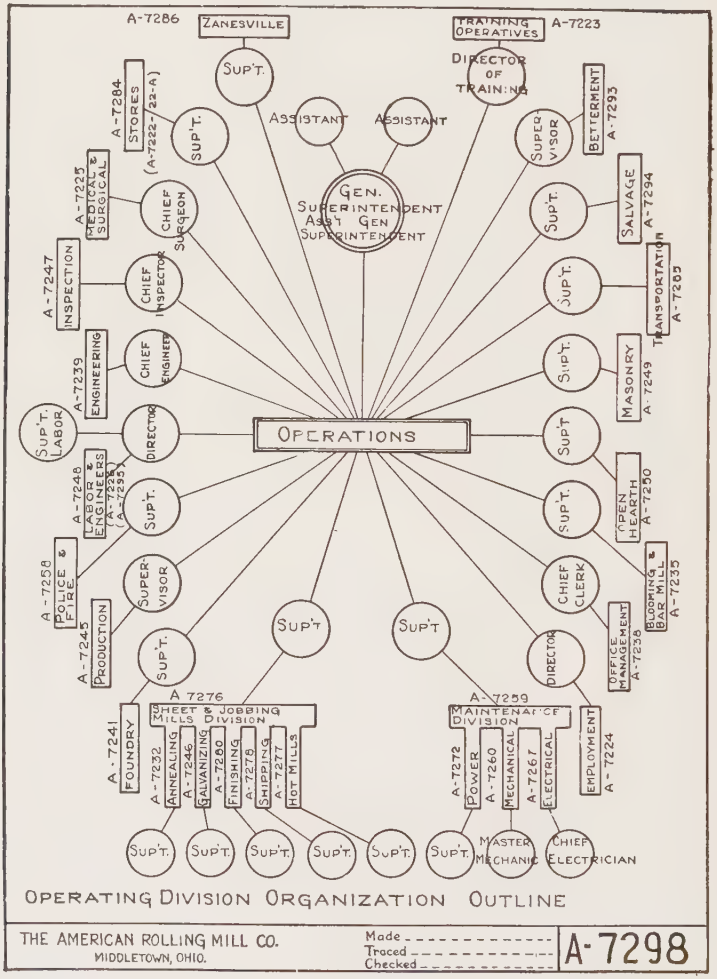


FIG. 6.

working hours and conditions. As has been previously indicated, in this type of business, purchasing will ordinarily represent a major division of the business and, in this case, research has likewise been made a main division. The separation of quantity and quality under manufacturing should be noticed, as should the position in the organization of the free-

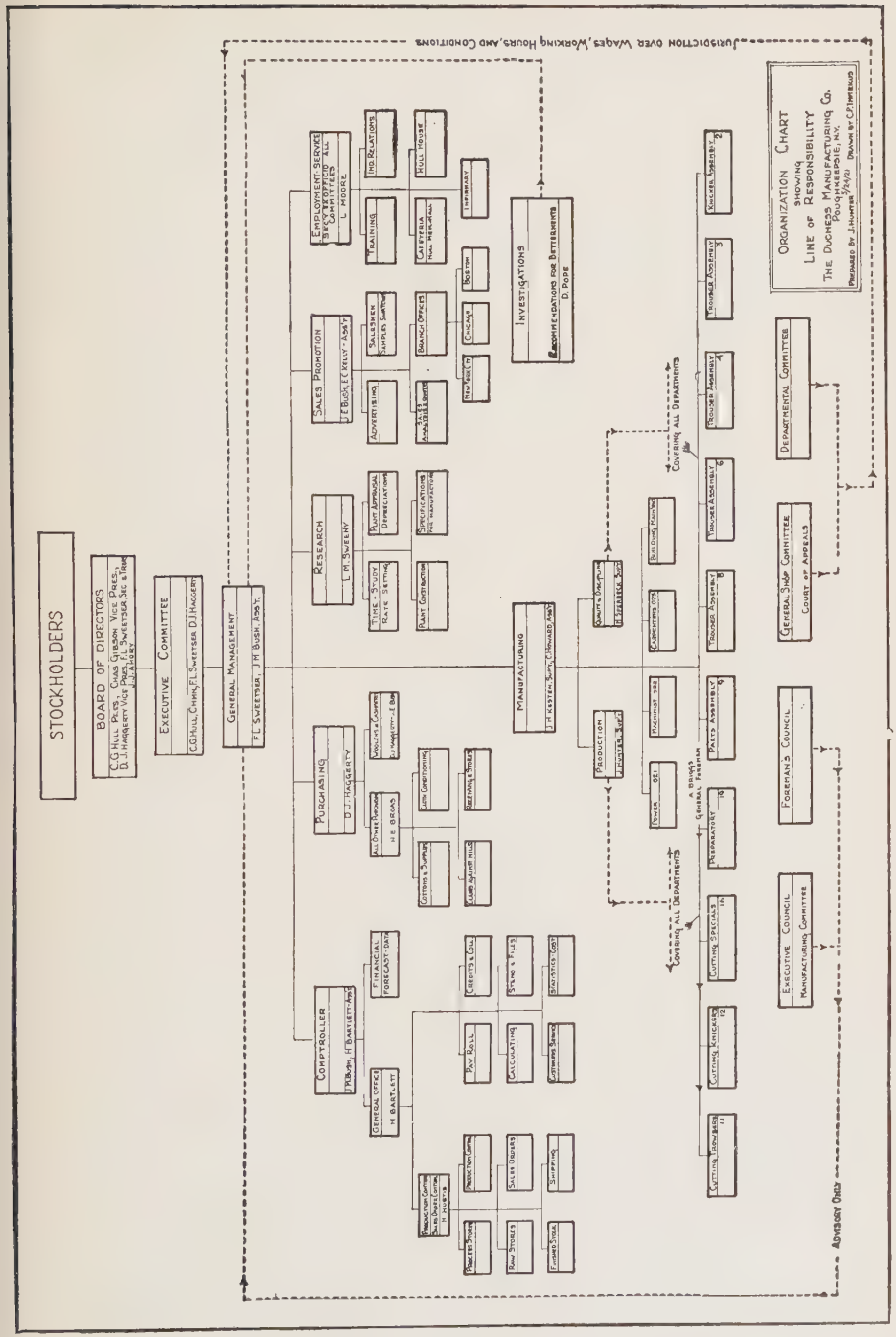

STOCKHOLDERS
BOARD OF DIRECTORS
C.G. Hull Pres., Chas Gibson Vice Pres.,
D.J. Haggerty Vice Pres., F.L. Sweetser Sec. & Treas.
EXECUTIVE COMMITTEE
Consul. Chmn. F.L. Sweetser D.J. Haggerty
GENERAL MANAGEMENT
F.L. Sweetser, J.P. Bush, Asst's.
Jurisdiction over Wages, Working Hours, and Conditions
COMPTROLLER
P.B. Sm., H. Bartlett Asst.
GENERAL OFFICE
H. Bartlett
FINANCIAL FORECAST DATA
PURCHASING
D.J. Haggerty
RESEARCH
L.M. Sweeny
TIME-STUDY RATE SETTING
PLANT APPROVAL SPECIFICATIONS
SPECIFICATIONS FOR MANUFACTURE
PLANT CONSTRUCTION
SALES PROMOTION
J.P. Bush, J.F. Kelly Asst's
ADVERTISING
SALES MANAGEMENT
BRANCH OFFICES
NEW SALES
CHICAGO
BOSTON
SALESMEN SALES DATA
EMPLOYMENT SERVICE SECRETARY OFFICE ALL COMMITTEES
L. Moore
TRAINING
TIME RELATIONS
CAFETERIA HULL MEMORIAL
HULL HOUSE
LIBRARY
INVESTIGATIONS
RECOMMENDATIONS FOR BETTERMENTS
D. Ross
MANUFACTURING
J.F. Kelly Sr., Sm., C. Howard, Asst's
PRODUCTION
PLANNING, ROUTE
ROUTE SHEETS
DISPATCHING
POWER
MACHINERY
PARTS ASSEMBLY
PREPARATORY
CUTTING DEPARTMENTS
CUTTING KNIVES
CUTTING BANDSAWS
EXECUTIVE COUNCIL
MANUFACTURING COMMITTEE
FOREMAN'S COUNCIL
GENERAL SHOP COMMITTEE
COURT OF APPEALS
DEPARTMENTAL COMMITTEE
COVERING ALL DEPARTMENTS
CARPENTERS SHOP
BUILDING PAINTING
ROUGHER ASSEMBLY
FINISHER ASSEMBLY
SPECIAL ASSEMBLY
ADVISORY ONLY
ORGANIZATION CHART
SHOWING
LINE OF RESPONSIBILITY
THE DUCHESS MANUFACTURING CO.
POUGHKEEPSIE, N.Y.
PREPARED BY J. HUNTER 3/24/21 DRAWN BY C.P. IVERSON

Fig 7.

lance investigator who makes recommendations for betterments to the general management. The placing of certain specific duties as, for instance, production control, in a far different position from that indicated in the typical organization chart, merely illustrates the necessity for consideration of the personal equation in the building up of an effective working organization.

A home-office organization chart. The organization chart of the Walworth Manufacturing Company, manufacturers of pipe fitters' and

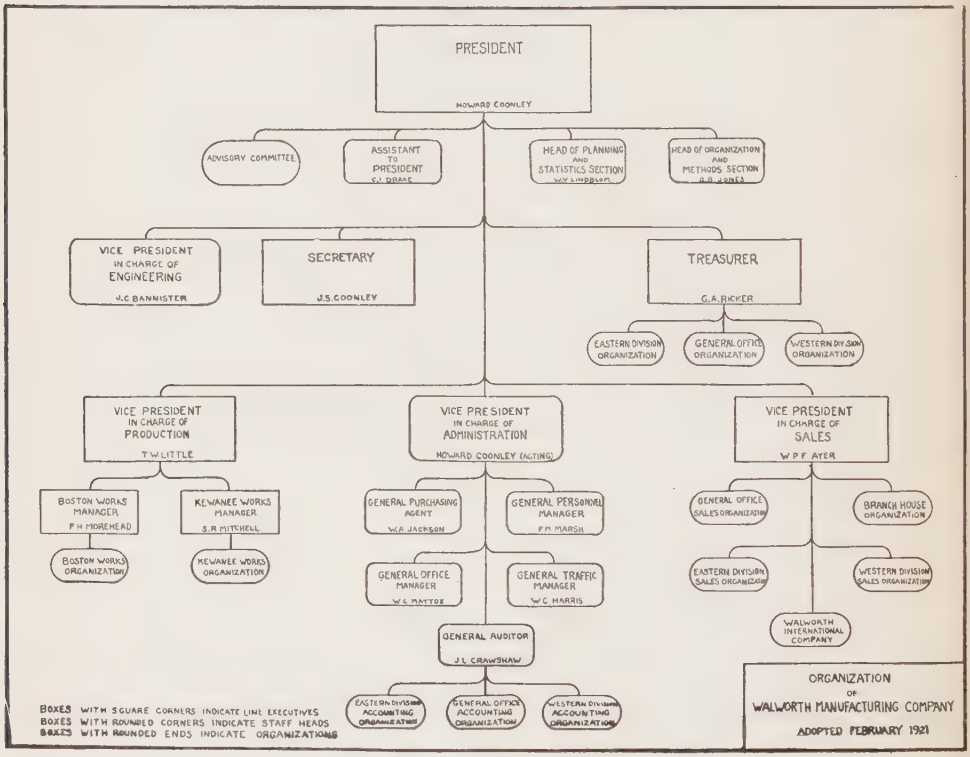


FIG. 8.

plumbers' supplies, with plants in Boston, Mass., and Kewanee, Ill. (Fig. 8), well illustrates a finely developed home organization for a business operating two plants, various sales offices, branch houses, and engaged in the export trade. The method of placing functional assistants in charge of staff departments directly under the president and general manager indicates the way in which control may be obtained over widely separated portions of an organization. The organization of the sales division, with its departments in charge of branch houses, and the export organization should be noted. This is an excellent example of the application of the functional idea to home-office organization.

CHAPTER VII

ORGANIZATION INSTRUCTIONS

When discussing rules and regulations as an operating fundamental of organization it was shown that one of the chief methods of presenting these to the personnel of an organization was through the utilization of standard instructions. Standard practice instructions place in black and white developed organization details, and transmit these to all members of the organization who are affected. A standard instruction operates on an organization somewhat as would a ratchet. A degree of perfection is reached, the standard instruction is issued to describe this, and the chance of retrogression is minimized.

The importance of standard practice instructions to an organization will be clearly indicated, if we but think, for a moment, of the many achievements of ancient civilization which were lost to the people of the world for centuries, because of the absence of means of recording in ancient times. The business which does not record its important organization details in standard form is in much the same position as the ancients. It is just as difficult to retain, within the business, the advances which are made, and the methods of procedure which are developed, unless these are written down, as it was difficult for civilization to retain knowledge of the methods of manufacture of Egyptian bronze or Toledo or Damascus blades.

Some managers have come to feel that one of the best measures of the extent of good management within a concern is the extent to which it uses standard practice instructions. It is evident why such might be the case. We frequently speak of rule-of-thumb management as the opposite of modern management. Under rule-of-thumb management, action can be secured upon a problem only when the occasion arises. This results in thinking of each problem separately, so that such shops have their great body of common practices which have gradually crept in, and which are largely unrelated. Methods are variously understood and variously interpreted by those most affected. The traditions of the past are treasured up in the minds of the oldest employees, who transmit them upon occasion, much in the way that the ancient bards were accustomed to transmit the history of early times.

In the development of standard instructions it is necessary not only to think clearly and to think through the subject of the instruction, but it is necessary to think ahead. It is evident, therefore, that standard practice instructions within a business indicate a tendency on the part of the executives of that business to think clearly, to think through and to think ahead.

Uses of standard instructions. The general reason for utilizing standard practice instructions is to give orders through the proper organization channels of the business. They are used to show the scope of or lines of authority within the organization, or to describe methods of procedure. A procedure involves the inter-relationship of two or more persons in the business.

To use standard practice instructions to show the scope of authority of each of the members of an organization makes them an interpreter of the organization chart, if there be one. It is impracticable to show on the face of such a chart all of the necessary facts. Consider a manufacturing organization in which the functions of finance, sales, personnel, and manufacturing are segregated, and the persons in charge of these functions are responsible to the general manager. Standard practice instructions define the general responsibilities of these divisions, together with the relation of one to another. They extend to the departments of the divisions, then to minor sections, so that each member of the organization is fully acquainted with his duties and relationships to others in the organization. These standard practice instructions are not necessarily fixed; in fact it is the usual thing to find them under constant revision. Their value is that during the periods of change existing relationships are maintained until they are superseded in written form by new information. The value of standard practice instructions, showing scope or lines of authority, is increased when functions are transferred from one member or department of the organization to another. If they are of value in stating current conditions, they are of greater value in bringing changed conditions to the attention of all within the organization.

Figures 9 and 10 are excellent examples of standard practice instructions showing the scope of authority. In Fig. 9 are set forth in great detail the duties of each member of the organization. Figure 10 is an example of the type of standard instruction which creates a new function within an existing organization. The names on Fig. 9 have been changed from the original.

To describe methods of procedure is the second reason for the preparation of standard practice instructions. Examples of such instructions might include instructions as to the handling of complaints, instructions concerning action to be taken on certain paper work, or instructions concerning the method of estimating the demand for a new article or line

FIG. 9.

THE SPARKS-WITHINGTON COMPANY

JACKSON, MICHIGAN

Organization Bulletin No. A 21

GENERAL ORGANIZATION

Effective Wednesday, June 1, 1921, the general organization of The Sparks-Withington Company will be as set forth in this bulletin and organization diagram drawing No. 287 dated May 27, 1921. Detail amplifying more fully the duties of various departments has been covered by bulletins and this bulletin may be changed or amplified from time to time as subsequent organization bulletins are issued by the management.

EXECUTIVE HEAD

MR. WILLIAM BROWN, General Manager

In general charge of all Company activities; in direct charge of New Products Division, also Sales and Advertising.

PRODUCTION HEAD

MR. W. J. FORBES, Asst. General Manager

In charge of all matters under General Manager's authority and during absence of General Manager. In direct charge of Planning and Purchasing Division, Service Department, and Welfare Work.

NEW PRODUCTS DIVISION—Mr. T. J. Scofield; Foreman, L. E. Johnson

Experimental work and such special duties as may be assigned to this department by the General Manager.

SALES DEPARTMENT—Mr. H. G. Brown, Jobbers' and Export Sales
Mr. O. M. Brown, Manufacturers' Sales

Will co-operate with Advertising Department, Service Department, Order Department.

Mr. H. G. Brown will authorize the issuance of shipping orders to the jobbing trade, production of which will have been planned for by general production plans. Special orders to be taken up with the Assistant General Manager for approval before being entered.

Mr. O. M. Brown will pass on orders for shipment of material to manufacturing trade. Will see that complete records are filed from which quotations were made so that estimates and such figures will be available for the cost and methods departments for comparing with production experiences.

FIG. 9.—*Continued on page 86.*

FIG. 9.—*Continued.*

ADVERTISING DEPARTMENT—Mr. Max Corning, Adv. Mgr.

In charge of production of all advertising matter and direct such advertising campaigns as may be authorized by the management.

Co-operation with the Sales Department of course is primarily essential.

Co-operate with the Purchasing Department in procuring competitive bids on such advertising matter as may be required.

Act with the Purchasing Agent and Office Manager in procuring general printed matter for factory and office use, of the most satisfactory kind and at the most favorable prices.

ACCOUNTING DIVISION—Mr. H. M. Tilden, Treasurer

Accounting and Costs; responsible for financial matters and for the gathering and recording of costs and results of operations.

Stenographic Department, filing, sales department clerks, purchasing, planning department clerks, factory production clerks, and other clerks on miscellaneous work; authorize the purchasing of office supplies and stationery and office mechanical equipment.

Accounting—Mr. R. Bliss
Costs and Payroll—Mr. M. Bettendorf
Stenographic work—Miss C. Olsen

PLANT OPERATING DIVISION—Mr. H. A. Black, Factory Manager

This division will work in co-operation with the Assistant General Manager on all production matters.

It will co-operate with the Planning and Purchasing Division in completing production schedules in accordance with the orders and quantities required by the Planning division and our customers' requirements.

Engineering Dept.—Geo. White, Chief Engr.
Operating Div.—Mr. Burchard, Superintendent
Mechanical Div.—Mr. Emery
Inspection Div.—Mr. Poor
Methods Div.—Mr. Carney
Transport Div.—Mr. Blanchard

Mr. White is chairman of the Operating Division Committee.

The head of the Inspection Department will co-operate closely with Assistant Factory Manager in the matter of inspection and maintenance of quality standards.

to be added to those already manufactured by the company. Such standard instructions clearly indicate the way in which successful management operates. When occasion arises for the development of such instructions, the manager in charge of the function involved sees that the standard instruction is prepared and put into the hands of those who must operate under it. Once this is prepared, the matter does not again come to the executive's attention, except when a change in the instruction becomes necessary.

FIG. 10.

UNITED DRUG COMPANY

ADMINISTRATIVE ORDER NO. 17

June 16, 1921

SERVICE MANAGER

1. The chief of the Service Section of the General Production Staff will be known as the Service Manager. He will obtain decisions from the Production Manager of the company concerning general policies of distribution, the establishment of warehousing facilities, etc., and will promulgate instructions concerning same to all parts of the production organization affected.

2. He will act in an advisory capacity, concerning storage and service matters, to the managers of all plants which have any storage or service activities. He will prepare bulletins, covering all more or less permanent instructions concerning storage and service activities, for issue in the regular manner and will also prepare, for signature by the Production Manager, all temporary instructions which he desires to have issued. He will, however, maintain direct relations with the plant managers and will give them formal and informal advice and assistance.

3. To aid and assist him in the performance of his duties the Service Manager will organize a staff, functionalized as follows and charged with responsibilities as outlined below:

Traffic
Storage
Adjustment
Facilities
Procedures

Figures 11 and 12 are examples of this second type of standard instruction. Figure 11 was prepared in a Government office during the war when conditions were in a state of flux. The personnel was new, the conditions which were being faced were new, and it was necessary to indicate clearly all procedures in detailed, written form, as well as to designate the responsible person by name rather than by title. The utilization of standard instructions frequently allows complicated procedures to be developed and worked without friction by an essentially "green" personnel. Figure 11 indicates the necessity of correlating lines

of organization with methods of procedure, when developing the latter. Figure 12 indicates an effective way in which a procedure may be visualized through the use of a chart form of standard practice instruction.

FIG. 11.

DETROIT DISTRICT ORDNANCE OFFICE

PROPERTY SECTION CIRCULAR NO. 47

7/5/19.

Subject: Paper Work Procedure on Sub-Contracts of Cost Plus Prime Contracts

1. Attention is invited to Property Section Circular Letter No. 92 which provides a procedure for handling property in case of sub-contractors of cost plus prime contractors.

2. Mr. Laib is in charge of preparation and routing of all papers under this procedure. He will receive from the Cost Accounting Section necessary vouchers and inventories which will indicate what material is to be taken over by the Government from the sub-contractor and the point at which it is located. He will immediately cause to be made up receiving reports for material as listed on the inventory and secure a voucher number from the Stock Record Section for these receiving reports. However, he will hold the receiving reports until such time as material has been properly checked and no entry will be made on stock record cards until such time as Mr. Laib has ascertained that the property is actually on hand and until it has been removed to Government storage in this District, or, if it is located in another District, until it has been transferred to the Property Manager of that District.

3. If the material is located in the Detroit District Mr. Laib will cause it to be moved to the Detroit Ordnance Storage Depot and will prepare shipping tickets invoicing the material to the Commanding Officer of the Detroit Ordnance Storage Depot. If it is located in a foreign District he will prepare shipping tickets to the foreign District and will forward these with a letter of transmittal explaining the transaction to the foreign District Property Manager. For both types of transactions Mr. Laib will secure the serial number of the shipping tickets from the Stock Record Section but in the same manner as in the case of receiving reports no entry on the stock record cards will be made until it has been discovered that all property has been located.

4. At the time that Mr. Laib secures information that the property has either been moved to Detroit Ordnance Storage Depot or has been accepted by foreign District Property Manager, he will release both receiving reports and shipping tickets, and entries taking up and dropping material from the stock record cards will at that time be made.

5. In case discrepancies are found to exist in the material, receiving reports and shipping tickets will be cancelled and new ones prepared either using same voucher numbers or releasing these voucher numbers for use on other transactions.

Preparation of standard practice instructions. Standard practice instructions may be prepared and transmitted individually, or as a whole procedure or "standing order." If they consist of a series of consecutively numbered memoranda they may be given any name which fits the individual circumstances and the desires of the executives. Among the titles ordinarily given such memoranda are, "administrative orders,"

"methods bulletins," "organization bulletins," and "production circulars." The signature of such instructions varies usually with the group that they are intended to affect. Sometimes they are issued without signature when all instructions emanate from the same source. Ordinarily, in order to give full authority to the instructions, they are issued over the signature of the general manager, in those cases in which more than one division of the organization is affected. They are frequently issued over the signature of the division head when the instruction applies specifically to a particular division, but even in such cases they are often countersigned by the general manager.

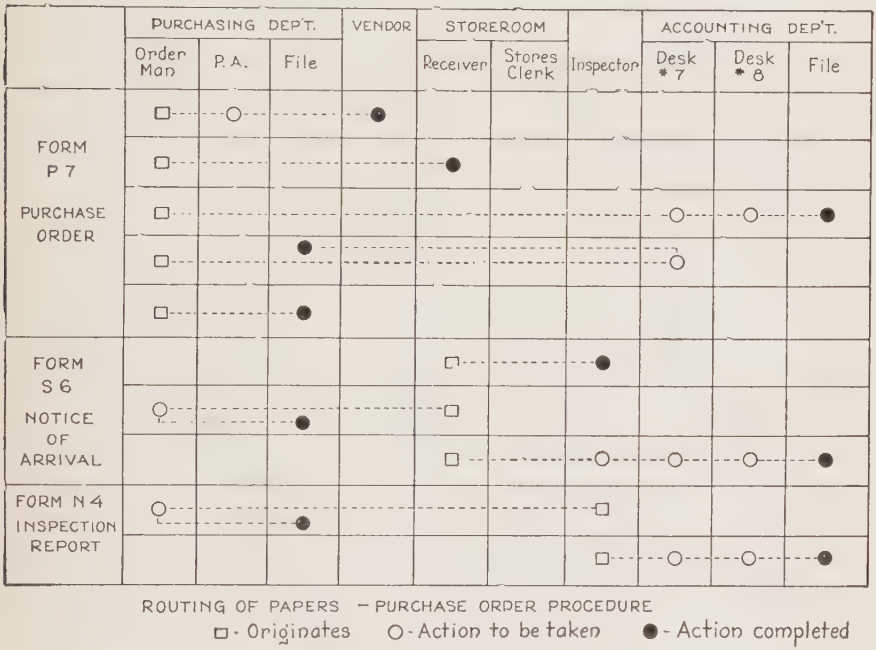


Fig. 12.—A Procedure Chart.

Advantages of standard instructions. Standard practice instructions are advantageous and vitalize the development of the organization fundamentals within a business because (1) they are not likely to be misunderstood, (2) they are less likely to be forgotten, (3) they fix responsibility for mistakes, (4) they clarify the ideas of those giving the orders and thus insure careful thought, (5) they make for change in method that is continuously forward, (6) they expedite the routine to be followed by members of the organization, (7) they constitute a ready-reference file of executive decisions. It should be carefully noted that their existence does not necessarily imply that the contents of all orders must be memorized, but rather that the individuals whom they affect may use them for

ready reference when in doubt or when questions of procedure arise. On the other hand, the orders most frequently utilized are likely to be kept in mind by all employees affected.

Why standard practice instructions sometimes fail. Standard practice instructions have frequently failed in operation. Their failure can usually be ascribed to one of several causes. These are (1) too many orders, (2) not enough care in preparation, and (3) the preparation of the instructions is sometimes delegated too far down in the organization.

Too many orders may be the result of one or two difficulties; either orders issued from too many sources or too large a number of orders. Much difficulty has at times been caused with the development of standard instruction procedures because orders within an organization have been issued from two or more persons. This does not imply that the general manager and the head of the division may not both issue orders, but the scope of their orders should be carefully defined with reference to each other. The difficulty comes when two people begin issuing orders on the same class of details or procedures. There is nothing which will break down the force of standard instructions more than to have two conflicting instructions, both supposed to be binding. The effect of too large a number of orders is almost equally as bad. An order which is numbered, for instance, 546, is likely to be lightly regarded. The impossibility of keeping such a mass of instructions in mind is clearly evident to everyone. If it is necessary to revise order No. 36, it is desirable to call it order 36-A merely for the effect on the persons concerned. In general, people resent being ruled, and the fewer orders and rules, the better the reaction. Standing orders should only be gotten up when necessary, and to issue them too frequently makes them lose much of their force.

The second chief reason for failure that must be guarded against when preparing standard practice instructions is the failure to utilize sufficient care in preparation. An instruction should never be issued until it is certain that further consideration would not aid in bettering the working of the provisions made. Companies have at times abandoned the use of standard instructions after their use has once been adopted. Failure to guard against this danger is the most frequent cause of such action. Lack of care in preparation may include either the use of terminology that is not clear or failure to visualize all the implications involved in the order being transmitted. Terminology may ordinarily be clarified by either the issuance of a special bulletin on that subject or by proper explanation at the beginning of each bulletin. It is from failure to give full thought to all implications of the order that more important difficulties arise.

An order which is hastily prepared and issued usually needs amendment. Many amendments will promptly break down a system of standard practice instructions. Some cases have occurred where those in charge of

issuing the orders have come to the point of relying on criticism of the order after it is issued as the basis of the real thought devoted to the subject. This plan is based on the general hypothesis that amendments will be necessary anyhow—so why think twice? Soon everyone in the organization gets the idea that all orders will soon be amended anyhow—so why obey them? They begin to have amendments of their own adopted if they do not like the order. Trouble then reaches its zenith. To be of value, the standard instructions must therefore be not only explicit, but correct when first issued. The development of the committee idea in management can be of great aid in the formulation of standard instructions. If department heads are thus consulted and the subject discussed from every point of view within the group affected, there will be no complaint, and few amendments, and the system will ordinarily prove highly successful. All of the advantages of utilizing committees come into particular prominence in this development.

The third reason for failure of standard practice instructions is that some person too far down in the organization scale is delegated to prepare them. This defeats much of the purpose of standard instructions, which is to insure at all times chief executive direction, together with the operation of the exception principle. If a subordinate be delegated to prepare the instructions, the subordinate is actually running the department, if the instructions are observed. However, such a condition frequently results in a large number of amendments by the chief. It is often the cause of the issuance of too many orders, since all interested viewpoints have not been taken into account in the first instance.

CHAPTER VIII

MORALE-BUILDING VS. MORALE-DESTROYING ORGANIZATION

The executives of a large manufacturing establishment that must be nameless were recently astounded when, at a supervisors' meeting at the works, the general manager announced a complete change in the policy of organization development which had been gradually progressing. The general manager, who had been carefully constructing what he had termed a modern organization, called this meeting for the specific purpose of stating that he felt that much of the organization work which had been done under his direction was bad, and that he would shortly make an announcement concerning a return to the older plans which he had so criticized at previous meetings. Speculation immediately became rife as to the cause of the change of heart. The secret lay in something none of the executives could have ever known—in a trolley-car conversation that the general manager had overheard not many days before. It was between two of these same executives, but not intended for all the ears that heard it. It ran about as follows:

First man: "Well, I see there's another organization chart out to-day. Old Crawford is getting as bad as the evening papers in putting out editions."

Second man: "And that's not the worst of it. Every time a new one comes along, it has a bunch of new lines on it. They're getting to look like cobwebs."

First man: "Yes, and what's more, every new line means something more that can't be done or must be done. It's getting so that the only two respectable English words I know are 'must' and 'can't'."

Second man: "Well, anyhow, we are organized."

Mr. Crawford had thought quite a lot about that little conversation. It had worried him, and he began to sense that possibly, in trying to create a smooth, well-oiled machine to run the business, he had not considered as a factor the loss of much of the enthusiasm, much of the support of his subordinates. His resulting action, as it should not have done, went to the other extreme. But he began to perceive, as other executives have perceived, that in organization development it is necessary to carefully analyze all steps in order that they shall lead in the direction of a morale-building organization rather than toward a morale-destroying one.

Carefully developed organizations that are morale-builders succeed. Carefully developed organizations that are morale-destroyers fail.

A morale-building organization utilizes fully the skill, initiative, judgment, and training of its members, and through such utilization succeeds in building up these and other qualities in everyone, so that the abilities of all constantly expand, and the organization is thus able to succeed and grow. All members of the organization are constantly encouraged to assume greater responsibilities. Thus all executives become accustomed to think of the duties, responsibilities, and difficulties of their co-workers, with the usual result of co-ordinate action and growth in capacity of the individual. As such businesses grow, and they generally do, opportunities for the fulfillment of the aspirations of their members are afforded.

In morale-destroying organizations, restriction of the individual is the keynote. The organizer has generally hoped to make his careful development of organization fundamentals so perfect that unusual, as well as usual or routine, matters will be promptly and properly taken care of in a routine way. The organizer has endeavored to impress his will on the daily actions and relations of all members of the enterprise throughout the business days to come. Into such organizations individuals enter full of enthusiasm, full of a desire to make their tasks and themselves grow, and, through them, the business. It is not long before they become aware of the restrictions that have been imposed, before they learn that the energy they are utilizing in the performance of their tasks is not needed or is not appreciated. They endeavor to utilize some initiative in their daily operations; they find they are hindered by lack of authority. They try to temper their decisions with judgment; they find it is not accepted or is hampered by supervising judgments. They strive for quick action on important matters; they find this is impossible because of the minute balancing of responsibilities. They hope for promotion and greater responsibilities by adherence to their task; they find that this is merely looked upon as making them more valuable in their particular niche, or is disregarded as promotion is made on almost any basis except fulfillment of duties assigned. The result of such conditions is uniform. If the subordinate be worthwhile, if he has sufficient strength of character, and if personal problems do not prohibit, he resigns. If he remains with the business both his character and his ability decrease and deteriorate until he is no longer worthwhile.

The line of demarkation between morale-building and morale-destroying organizations cannot be definitely drawn. Conditions which place particular organizations in either category do not develop overnight; and even if it is appreciated that tendencies toward morale-destruction are present, it is difficult to determine when they should be encouraged, as tending toward good organization, and when they should be eliminated,

as apt to bring over-organization. For morale-destroying organizations are generally cases of over-organization, although under-organization may also be morale-destroying. The very elements which make for morale-destruction, if applied in proper quantities, make for morale-building. An example of this is the proper fixing of responsibility. This fine line of demarkation is used frequently as the excuse for failing to make any attempt to organize. Executives, whose only reason for not developing real organization in their phase of the business is lack of ability or laziness, will point with horror to the dire results of over-organization that have occurred, as if they were common results of any intelligent attempt at organization work.

Conditions that bring morale-destruction. Since there is such close resemblance between well-developed organizations and morale-destroyers particularly in their formative periods, it is necessary that there be considered some means of determining what conditions are likely to bring with them the baneful results. But these conditions, to a certain extent, are essential for good organization development and there are no definite rules which can be used as a guide in keeping away from the dangers of over-organization. There are only certain dangers which must be kept in mind, and all factors must be thoroughly investigated if they appear to be of importance. Evidences of the appearance of any of these dangers should be sufficient to cause a manager to pause and ponder, to intelligently question whether he be developing better organization or whether he be merely restricting the activities of subordinates. The most important of these dangers are: too fine division of authority or responsibilities; too many supervisors; improper selection of personnel for new or expanded duties; over-reliance on organization charts; and too few real executives. Any of these conditions is likely to arise in the course of intelligent, well-developed organization work, and their effect must be kept in mind constantly, when considering the fundamentals of organization and other factors which are likely to cause them to appear. If the organizer can strike a proper balance between these factors, which at times may seem opposed, he will have developed an organization that will really function and is capable of growth.

Too fine division of authority or responsibilities. Too fine division of authority or responsibilities is likely to result if careful thought has been given to differentiation between activities that must be carried on. Although division of authority and responsibility is an essential, this must not be carried to a point that will preclude original thinking on the part of subexecutives. The development of cogs in a machine, rather than thinkers, must be guarded against. This does not necessarily mean that responsibilities may not be finely divided, or that those entrusted with responsibilities may not receive the expert advice of others along

particular lines of work, in order that best-known practice may be adhered to. However, it does mean that initiative along the particular line in which he is engaged must be left each executive, in order that he may take pride in the accomplishment of some definite phase of the work, however small. A long train of conditions inimical to successful operation will be started if initiative be denied subexecutives. It will ordinarily result in the development of organization cogs who may be mechanically excellent in performing daily duties, but totally unfit to meet emergencies, or to take higher positions, which from any cause may become vacant. This last condition forces the management constantly to bring in higher executives from the outside. The final result is that confidence in the business is lost by those on whom its success largely depends, the subexecutives in direct charge of operations.

An example of what to do, rather than what not to do, will best illustrate this point. This is to be found in the correspondence division of a large manufacturing plant in the Middle West that operates many agencies. Here lines of supervision and fixed responsibilities, as definite as any known, have been developed, and yet this has been handled in such a way that each member of the division has been given some work to do which involves originality and the free play of initiative. This condition has been combined with the task idea so that each correspondent has her own complete job to perform. Instead of all correspondence going through supervisors who indicate what the answers are to be, or who dictate them, work is divided among the various persons in the division so that each one receives a certain type of communication and acts upon it. Of course, rules of action are rather complete, but there is much possibility for interpretation of the rule as applied to an individual case. The greatest gain is that each person has her complete job, with the incoming correspondence as the raw material, and the letter which she writes as the finished product. Instead of a condition which might easily have developed in such a department, where everybody in a huge room felt that she was merely a cog in a great machine, a state of mind has been built up where each person feels that she has a definite, vital part to perform in the continued success and growth of the company. A whole department has been practically made into a group of subexecutives who have a feeling of confidence in themselves and in the company, and who are able to smooth out unusual situations as they arise, as well as being able to advance to higher positions as they are open.

Too many supervisors. The second danger which in some phases is very similar to the first, is that of too many supervisors. Such a situation results in conflicts of authority, and failure of the business to progress as might be expected, because of the lack of the push which can be only secured by direct, military supervision. The more carefully organized

the concern may be, the more is the chance for this development. The manager or organizer sees a function which is not being performed, and thereupon creates a department or delegates an individual with the responsibility for the performance of this function. If the attention of the organizer be directed to the creation of his technically correct organization, rather than to the cost of supervision or to the driving push so frequently necessary, this condition is particularly apt to arise.

Many executives are fearful lest they run up "non-productive labor costs" to too high a figure. This fear is groundless, providing the costs may be made to repay themselves, but is very real if functions be developed which cost more to operate than they return in cost-reduction. Much of the confusion incident to this situation arises from the use of the term "non-productive" to describe overhead or supervisory functions. This accounting term has often been changed in recent years to "indirect" or "overhead labor costs," and the change has eliminated much of the confusion. From a management standpoint, labor is non-productive only if it does not return to the business more in savings than it costs. There can be no objection to doubling or tripling the indirect labor cost, if by so doing direct costs may be so reduced as to decrease the unit cost of the articles being manufactured or sold. The inherent fear that many executives have of running up supervisory costs results in scanning payrolls to see if the aggregate of such costs cannot be reduced, without regard to the savings effected by the supervisors in question. This is not only groundless, but has the effect of throttling intelligent organization development. On the other hand, there is a very definite danger of allowing functions to be created, merely because they seem to be different, and without an adequate check being provided to see that they are or can be made to be paying investments. There is a very real danger of developing a situation where "for everyone doing productive work there is another man standing over him to see that he does it." The development of too many supervisors in an organization leaves most of them without sufficient real work to do or responsibilities to perform, with the result that they begin to get jealous of having their spheres encroached upon by others, and everyone begins watching everyone else, instead of pulling together to put programs through and to intelligently direct productive effort. It is such conditions which permit of the many profit-making sweeping eliminations of supervisory forces that are used by other managers as excuses for not building up normal, necessary, functionalized departments.

Improper selection of personnel. The third danger lies in the improper selection of personnel for new or expanded duties. Organizations, otherwise letter-perfect, have failed to function because of improper action in this regard. What frequently seems the easiest and best method of

handling this personnel situation is to create a function and then seek a new person with the qualifications desired, if such a person is not easily found within the organization. Such is the procedure usually when a cut-and-dried organization chart is used, as when several branch houses are organized on the same basis. One difficulty with such practice has already been pointed out under "Regard for the Personal Equation" as a fundamental of organization. It is difficult, under any circumstances, to find the person with the exact qualifications desired; but another difficulty is the effect of this practice on others who have long been with the company. Only under most unusual circumstances should duties be outlined which clearly will necessitate the bringing in of new personnel over old, unless another grouping of duties which would allow the utilization of the old personnel is clearly out of the question. Maintenance of morale demands attention to this point.

Conversely, it is essential that mere seniority within the organization shall not be allowed to govern organization development. Education and the intelligence levels of the persons concerned must be considered. It is true that in large organizations some orderly arrangement of promotion with length of service as a factor must be worked out, or the effect will be the same as bringing in new people for positions near the top of the organization; nevertheless seniority cannot be made the sole or even the most important basis of promotion. If it is seen that length of service clearly outweighs value of service in reassignment of duties or in filling vacancies the direct effect will be a let-down of effort among those subexecutives on whom the success of the enterprise most depends—those near the bottom of the ladder. The deadening effect of the application of the seniority rule can be found in the listlessness displayed by subexecutives and clerks in the offices of certain large railroad companies, whose promotion or organization development policy is based solely on seniority. Listlessness and clock-watching have become the rule of the day, and no amount of reorganization work seems to bring the personnel above the mere level of average, position-retaining performance. Thus it is clear that the manager, in building organizations, must consider his new or expanded duties in the light of two almost opposite reactions of his personnel, the aversion to the newcomer, and the necessity for—and, at the same time, the impossibility of—following the seniority principle. The effective organization is the one in which the tortuous channel around and between these conditions has been followed with success.

Over-reliance on organization charts. The fourth danger lies in over-reliance on organization charts. Properly used, these may be effective morale-builders; but improperly used, particularly if they become the keynote of operation, they are morale-destroyers. An organization chart is not an organization, but merely a picture of it. The pulsating, co-

ordinating activities of organizations can no more be shown in organization charts than can the tang of the mountain air and the stimulating effect of the mountain breeze be shown in a picture of a mountain region. Organization charts serve as guides in organization development, but cannot be looked upon as the result of the development itself. There are a number of reasons for this, which will serve to show the field of usefulness of the chart.

If the organization chart is looked upon as recording all the lines of supervision and all the responsibilities which have been placed, it will soon be found that its influence is too restricting. It tends to make the limitations on the duties of the various individuals too stringent and begets the attitude that anything which does not pertain to the particular department or section is no concern of the persons within that unit of the business. Such an attitude prohibits analysis of the work of others and therefore eliminates that necessary co-ordination which follows a knowledge of the other man's difficulties. Even if responsibilities are rather definitely stated under each main department or section, and attention is here called to the main lines of co-ordination, those most important co-ordinating activities of good executives which they take upon themselves in the daily conduct of their tasks cannot be adequately shown. This calls attention to the second main failure of the charts.

Frequently, since the greatest ability of particular members cannot be adequately depicted, the chart seems out of balance and causes the whole organization to question it. It has been shown that leadership frequently is made effective through some person rather far down in the organization scale. Divisions or departments of the business may be built around the personal qualities and trouble-smoothing abilities of this person. And yet such abilities are not picturable. If the organization chart be looked upon as more than a guide, this man's ability to lead and co-ordinate may actually be throttled. Thus, the free-lance assistant to the general manager who can eliminate much friction as it is about to get started, has duties which it is most difficult to satisfactorily portray on a chart.

Again, organization charts lack the flexibility which most growing organizations need. Emergencies arise daily which necessitate the reassignment of duties. Only by drawing up a new organization chart can these changes be shown. If the changes are made too frequently, the charts fall into disrepute, and if not made, either the charts are behind the organization changes, or the changes are not made when they should be. This can in a measure be prevented, by clearly indicating that certain alignments or duties are temporary, when a chart is prepared, rather than by making the organization outlines seem at least semi-permanent. Similarly, it is clear that, in reorganizing, it is frequently undesirable to indicate to line members of an organization that specialists

are encroaching upon their functions until this is an accomplished fact. Responsibilities must be changed or taken away with the greatest amount of tact and painstaking care and changes must be " sold " to the whole organization. This cannot be done if an organization chart is prepared on which there is emblazoned, so that the whole business may see it, the change of functions. As development work goes on, the " before and after " comparison is frequently made too easy, if organization charts are prepared each time responsibilities are changed.

These objections and inherent defects of organization charts do not demand that the charts be eliminated, though some executives have rather definitely come to that conclusion. They do demand, however, that charts be utilized with care, and with these considerations in mind. They demand that in developing organizations, charts be regarded more as a guide to those who are doing the developing, than as a standing order to all within the business telling each of them their authority and responsibility. Charts may frequently be made more workable, and these objections may be overcome, if supplemented by standard practice instructions; but of themselves, they can never be regulations for organization operation.

Too few real executives. The fifth danger of morale-destroying organization is relying on too few real executives. That is, relying in most phases of the business on the clerical type of individual as a supervisor with a few real executives holding the guiding reins. This condition is often the result of too fine division of responsibilities, but has equal importance and different results. Heads of departments or sections must be real executives. They must be able not only to control and supervise, but also to inspire the men and women under them to better and greater activity. Since no organization can be developed that does not need the lubricating action of executive control, it follows that men of real executive caliber are needed for effective operation. They must be able to sense dangers of morale-destruction within their own departments and therefore must be men who have the ability to lead as well as the ability to carry out orders or carry on functions. Organizers who consciously think of subordinate positions as being chief-clerkships rather than subordinate executive tasks are generally creating a flimsy structure which will not survive in time of business storm. Like other structures, organizations must be built to survive the maximum strain which may be placed upon them. In the ability and action of the executives throughout the organization lies the factor of safety. If provision has not been made for this factor of safety, the structure may collapse under the strain of unusual pressure.

The worth of any organization is determined in times of business stress, not in times of smooth sailing under favorable winds. Attention to

elementary phases of organization work, such as proper development in the light of the fundamentals, and in the light of conditions peculiar to the business, should provide a structure which will survive in smooth seas. It may not have the morale-building features that will enable it to survive when business conditions demand close harmony, initiative, and judgment on the part of every single person in the enterprise, in order that every slight advantage may be pressed and in order that real economies may be effected. It is such organizations that must, in times of stress, temporarily dispense with many of the key men for temporary payroll gain but for ultimate business loss. Adequate attention to the dangers of morale-destroying organization should enable the organizer to so build his structure that it will be morale-building and can survive any stress, can advance while other businesses are fighting for their existence, and can thus endure not only as a going but as a growing concern.

PART III

THE PHYSICAL SIDE OF THE PLANT

CHAPTER IX

PLANT LOCATION

Organization work has been seen to be a basic management step. But organizations must be given tools with which to work, and the most important of these tools is the factory building. The modern factory building is as distinct from its predecessor as is the modern organization from the former military type. Plants with new and modern buildings have operating advantages over badly housed factories which show quickly in the cost analyses. But the effectiveness of the factory building is itself largely determined by the plant location. Poorly located plants sometimes prohibit good layout, good natural lighting, or the development of a satisfied working force—all steps in which the structure of the plant plays a large part. But the most important phases of plant location deal with the dollars and cents gain or loss that a given location brings to the business, in comparison with its competitors.

In many respects, locating a large plant to employ thousands of people is more simple than locating a small plant. The large plant may pick and choose, make demands and have them met, whereas the small plant must make the best of such conditions as it can find, and turn these to its advantage. Sometimes, because it is small, it can cover itself with the blanket of advantageous conditions which a large plant has created in a certain locality. Thus, a labor supply of specific qualifications may often be created by a large plant in a locality, otherwise good for industries of its type, but in which no such labor supply has existed before. A few small plants may then establish themselves near the large plant with complete confidence that there will be a sufficient number of workers who are dissatisfied with conditions of employment in the large plant, to assure them an adequate labor supply. It is such conditions that aid the survival of small shoe factories in Brockton, small woolen mills in Lowell, and

small paper mills near Holyoke. The establishment of small factories near large ones in this fashion frequently aids in the migration of industries, as in the growth of the shoe industry in St. Louis and Milwaukee.

Major factors of industrial location. The greatest influences on the location of factories are exercised by the major factors of industrial location, labor, market, power, and raw material. These influence different industries in varying ways, depending on the type of commodity manufactured and its requirements for labor or power in manufacture, its demands for raw material, and its ease of transportation to market. These major factors frequently determine that a plant must be located within one of several areas in which these conditions are most advantageous for it. The exact location, within the general area, may be governed by other considerations.

Although the influence of the general factors of location are generally clearly recognized by the factory manager, sufficient examples will be given to indicate their effect. American pottery manufacture has developed, through many decades, in two main localities centering in Trenton, N. J., and East Liverpool, Ohio. Most pottery manufacture demands an exceptional grade of skill on the part of large numbers of the workers. This condition has caused new factories to seek these two centers for the location of their plants, although the materials used come from the four corners of the earth, and the product is marketed as widely. If a product be bulky, its value small, and there are no other limiting factors, it is likely to be produced near its market. Thus cheap furniture is manufactured in considerable quantities in nearly every large city. Conversely, high-grade furniture is mainly manufactured in localized centers where there is a supply of skilled woodworkers. Plants such as cement works cannot be located where there is an absence of fuel because of the large amounts which are needed in the course of manufacture. Thus, though because of its bulk, cement manufacture tends to be located near large cities, which are the greatest markets for its products, and though it needs bulky and cheap raw materials, nevertheless no cement plants are found in sections of the United States where fuel cannot be had at comparatively cheap rates. The influence of power is paramount in the location of abrasive and chemical plants, needing huge amounts in their processes, near the plentiful and cheap power of Niagara Falls. The search for cheap raw material has driven paper pulp plants far up into the spruce forests of Maine, Wisconsin, and Canada, despite the cost of transporting the bulky and relatively cheap product. Transportation costs on raw material are heavier yet, and locations usually provided originally for floating logs downstream to the pulp mill. But pulp mills need huge amounts of power also. So the location within the area of raw material has been at the point where water power has been available. Canning

factories are influenced in their location almost wholly by the raw material factor. Not all industries have been influenced by these major factors of location in their original start. For instance, the growth of the brass industry in the Naugatuck Valley of Connecticut or the tire industry in Akron can originally be ascribed to none of these major factors. However, after these industries once secured a footing in these locations, the advantages of labor supply and miscellaneous advantages inherent in specialized centers won for these two localities the recognition as centers of their particular industries.

Advantages and disadvantages of specialized communities. Given an area in which a factory may locate because of the influence of the major locating factors, the selection of a specialized center within that area is always of distinct advantage. Management problems are simplified in a variety of ways by mere location in an area which includes other similar industries within its borders. Not only is there a trained labor supply available in such localities, but the ease of financing the business and selling the product is enormously increased. Examples of this are found in the Kensington district of Philadelphia, as applied to carpet and upholstery goods, and the Naugatuck Valley district as applied to brass manufacturing. The banks in such communities are familiar with the needs of the business, have a knowledge of good business practice in the industry and usually are willing, to the limit of their ability, to aid in any legitimate way. Other industries located in one-industry communities, conversely, frequently find it extremely difficult to secure the co-operation of the bankers to handle their accounts properly. They sometimes are even forced to go out of town for accommodation in times of extreme need.

Buyers gravitate to one-industry towns to purchase their product. Sometimes, indeed, the whole market centers around the towns in which the goods are manufactured. Thus the periodic furniture expositions of Grand Rapids, Michigan, and Jamestown, New York, attract furniture buyers from all over the United States. The trade mark which indicates that the furniture is made in one of these towns aids the retailer in disposing of his stock, and increases his turnover and the manufacturer's sales. Such examples of the benefits which arise from location in one-industry towns are probably more or less familiar to all who have knowledge of American industry.

There are other benefits of location in specialized communities, which are at times lost sight of. An example of this is the location of machinery manufacturers who make the type of equipment which is used in the industry. Required machinery can be procured at short notice, and, more important, repairs to machinery can be quickly secured. If the machinery manufacturers are not themselves represented in the specialized center it is probable that separate repair shops will soon spring up, and

their presence will reduce shutdowns in time of stress to the lowest possible point, both in number and in time. That is a dollars-and-cents advantage which looms up big, particularly to concerns which are not large enough to maintain their own repair departments. A similar advantage of the specialized center is the influence that the industry exerts on municipal legislation or ordinances. Thus the silk industry of Paterson, N. J., has been able to have ordinances passed which eliminate the smoke nuisance from that city.

Difficulties inherent in location within a specialized area have caused problems to arise in some industries which are tending to cause manufacturers to move outside the specialized center. Specialization within an area, particularly a large city, brings with it unionization of the labor in the industry, or at least attempts in that direction. Those manufacturers who do not desire to employ union workers find this a cause for removal outside the area. Specialization within a community leads to much "shopping around" by purchasers in times of depression, and therefore their coming to such markets to buy is not an unmixed blessing to the manufacturer.

Location advantages of the large city, small town, and the suburb. A plant may locate in a specialized section and still have a choice of a large city, a small town, or a suburb of a large city. Such a choice is to be found particularly in such sections as the shoe region of New England, the automobile region of Ohio and Michigan, or the textile areas of eastern Pennsylvania or Massachusetts. If the specialized area be a city, many of the advantages of location within the city can be gained by location nearby. At the same time, some of the disadvantages of location within such a community may be avoided. Thus the automobile plants of Pontaic, Flint, and Jackson, Michigan, have most of the advantages of those located in Detroit, while at the same time they are not faced with the transportation problems or the tax expenses incident to location in a city the size of Detroit.

The big city location. The big city location has its distinct advantages. All the advantages of the specialized region are sure to be found here, and found in greater abundance than elsewhere. Besides these advantages, which need not be repeated, are unusual educational and amusement advantages. The educational advantages are not only those for the children of the employees, which may make the latter desirous of being in the larger town, but more especially the trade and industrial educational advantages. Evening schools for the workers, which make them more valuable to their concern and to themselves; discussion groups for the executives, such as advertising clubs, production and engineering organizations; foremen's training classes, and many other types of modern industrial educational opportunities are only to be found in the big city.

They represent a real reason for location in the city rather than in the small town. These advantages can usually also be enjoyed by the firm which is located in the suburbs, providing the transportation facilities are good.

Not the least of the big city advantages is the fact that, even in specialized communities, there is always available a more diversified working-force than is the case in smaller communities. It is always possible to secure male or female labor, as is desired. Of course, specialized communities which employ only male labor always tend to build up complementary industries, regardless of the size of the community. Thus the hosiery industry, which employs much cheap female labor, is found in Philadelphia, employing the wives and daughters of the expert weavers and the metal workers of the Kensington mill district. This same industry is found in the small towns of Pennsylvania employing the wives and daughters of miners, or workers in the steel mills there.

The advantages of big city location are offset by disadvantages, in the eyes of many industrial executives. For instance, the small plant is likely to be at a disadvantage in a big city because it is forced to find a location in a loft building. Though this type of factory building is particularly common in New York, it will be found in almost every large manufacturing city. The loft building is the refuge of the man who seeks to take advantage of a labor supply near at hand, as in the clothing trade of downtown New York, or the textile industries of northeast Philadelphia. The loft building makes difficult the development of modern management, not only in the concern that uses it, but in the whole industry nearby. It is difficult to maintain working standards against the type of manufacturing competition that rents a floor, rents machines, forgets the existence of overhead, and proceeds to make hay during the sunny times of industry. It is this type of manufacturing enterprise that is likely to be the first to fail in times of business depression, but in failing it cuts and cuts prices until it makes competition exceedingly hard for larger plants with big plant expense and a vision of the future. Once the loft-building type of concern gets started in a city, it is likely to clear the field of other types of the same industry in that city.

For instance, a report of the Factory Investigating Commission of the State of New York [1] showed the following percentages of the following big city industries of New York State were located in loft buildings: clothing, 78.4 per cent; fur, 58.9 per cent; tobacco, 52.6 per cent; flowers and feathers, 52.0 per cent. Although these figures represent numbers of plants, and not value of product, they are significant when contrasted with industries which, in New York, are essentially small-town industries.

[1] State of New York, Second Report of Factory Investigating Commission, 1913. Vol. II, p. 424.

The report showed that the following percentages of these industries were located in special factory buildings: gloves, 90.9 per cent; textiles, 84.0 per cent.

Another difficulty of big city location is the usual inability to provide for future expansion. The ideal location is not only one that will permit the plant to be built and correctly laid out, but will at the same time permit sufficient clearance space to be given on several sides so that additions may be made without necessitating a rearrangement of the machinery and equipment in the original plant. Central city locations do not lend themselves readily to expansion, except at enormous expense. The classic illustration of this is that of the Baldwin Locomotive Works in Philadelphia, which after expanding in its original location in the heart of Philadelphia for close to a century, was forced to seek additional room that it badly needed far from its original plant, twelve miles out of the city at Eddystone, Pennsylvania.

Another distinct disadvantage of city location which is intensified at the present time, is the high tax rate that is usually involved. This is a form of the higher cost of living that is general in cities. Other forms of the higher cost of living make it necessary to pay wages to employees higher than must be paid by plants in out-of-town locations. Not the least disadvantage of big city location is the difficulty of providing pleasant surroundings for the plant. This placing of the plant in an attractive setting is possible in some of the smaller of the large cities, as has been accomplished by the Eastman Kodak Company and The Art in Buttons Company of Rochester, New York. In larger cities it is practically impossible. In Philadelphia, New York, or Chicago it would be difficult to find a single plant with the parklike setting of either of those mentioned. This setting is believed by managers to be desirable up to a certain point in cost, and its necessary elimination in the big city must be put down as a distinct disadvantage.

The small town location. The chief disadvantage of the small town location is that it lacks practically every advantage of the big city. Labor supply, amusements for the high-salaried men, and other features are usually lacking in greater or less degree. It is an important fact that the high-grade executives tend to locate near the larger cities. Social advantages for their wives, amusement and musical advantages and the absence of the golf club from many small country towns are all factors which make it difficult for the large plant to locate away from the big city. The $10,000 man generally is not willing to spend most of his time in a place where he is not able to spend a substantial share of this sum on amusements or personal improvement of one kind or another.

The small town does offer certain very definite inducements that the large city cannot give. Low taxes, coupled with definite rebate of taxes in

many cases, is one factor. Many small towns give free land, or even erect buildings and give bonuses to large industries to locate within their borders. Thus the city of Cumberland, Maryland, secured the huge new plant of the Kelly-Springfield Tire Company largely because of such concessions. This factory was literally brought to Cumberland by popular subscription. There is a real danger in placing too much emphasis on these factors if more basic conditions are not advantageous.

The labor problem in the small town is entirely different from that in the great city. This is especially true for the first years after the establishment of an industry there. It is difficult for union leaders to organize people who are just beginning to work in factories, particularly if a large share of the working force is women, who are usually given an opportunity by the coming of the factory to earn more than they could in any other way. For those who fear union dominance, this appeals as a temporary advantage. Clothing concerns which definitely went out to small towns in Pennsylvania and Maryland for the single purpose of escaping the labor union have had some success. It is doubtless true that the degree of dominance of the union is always likely to be less in the small town, but if such a movement from the cities became important, there is no question but that union organization in the small town could be effected. Fundamental problems of industry cannot be solved by running away from them.

The cheapness of land in the small town leads to low buildings of one or two stories. This makes manufacturing layout and other production problems far simpler than they are in the multi-story buildings erected on the expensive ground of the city.

The suburban location. The type of location which provides most of the advantages of both the big city and the small outlying town is the suburban location near the big city. It is this fact that accounts for the very rapid development of the " metropolitan districts " near large industrial centers during recent years. The one-story structure is here possible, as in the case of the small town. The inducements are sometimes offered by the suburban community too; at least the ground is cheap and the taxes are low. The advantages of the big city nearby are usually to be had by all the staff sufficiently frequently to keep them contented, particularly if the housing conditions in the suburb are as good or better than in the city. Executives can utilize their automobiles either to go to the plant from their city homes or from their suburban homes to the city amusements. Railroad facilities are usually as good as they are in the city. In fact, they are likely to be better, in that spur tracks are easier to secure and they can be arranged to suit the needs of the plant. All the advantages of having several competing railroad lines, which usually are found in a big city, are to be had, and the dependence on one railroad

company, which is often the bane of the small town manufacturer's existence, is not faced.

There is practically no disadvantage that can be named for the suburban location. In fact the advantages of good working conditions that are usually found in the light, airy building that can be erected in the suburbs will be found to be a magnet that will draw the labor supply from even distant sections of the neighboring city. Industrial plants which have moved to suburban locations within recent years have found that they are able to take with them a large share of that portion of the force which they wanted.

Industrial housing. The development of the suburban location has brought with it the creation of industrial towns, particularly in the case of the large industries that have moved out. The industrial town, with its factory, its schools and its houses for the workers will be a greater factor in the future industrial development of the United States than it has been in the past or is in the present. The development of industrial towns, dominated by one or a few companies, in the suburbs of our large cities, is just commencing.

The industrial town is best known to the general public through its development in the remote mining camp of the West or the coal-mining regions of the East. Most of the publicity that it has received has not been favorable, and there is a prejudice against its development which must be overcome by the individual company. The modern development of this type of industrial community is not in the remote location, but in the suburb of the large city. Early attempts in construction of industrial towns were largely failures because of incorrect social hypotheses on the part of the builders. Too often the towns were built up on the basis of paternalism and misdirected charity, which had proved a success in industrial housing in Europe, but which proved a hopeless failure in the United States.

At the present time the solution of the suburban industrial housing project is being found in the co-ordination of industrial, civic, municipal, state, and national agencies so as to bring about the construction of attractive homes near the factory, under conditions which will permit the workingman to rent or buy a home within the limits of his resources. It is to be assumed that far greater advances would have been made in this type of industrial housing during the past few years had it not been for the extremely high cost of construction work.

Present industrial housing plans are being developed in the light of the experience, both of successes and failures prior to the war, coupled with the experiences of some extremely large and successful projects carried on during the war. Pullman, constructed about 1880, was the first of the large industrial cities. Gary, completed about thirty years

later, has secured the most publicity. Neither one of these towns has aroused generally favorable comment. Pullman was based on a paternalistic concept. At Gary the company did nothing toward the housing of the unskilled employee. Recent industrial towns have been more successful, as in the case of the United States Steel Corporation's next big project at Fairfield, Alabama, and the various United States Housing Corporation and Emergency Fleet Corporation projects during the war. A large share of these latter have now been taken over by a private industry, or private industries, and are being operated with distinct success. These developments were on such a scale as to furnish sufficient experience in industrial housing to move the whole program forward many years.

At the present time the industrial housing program promises to reach its full development. The acute shortage of homes and the price situation have made difficult the solution of the problems by individual action, and have made large-scale house production by specialized agents not only desirable, but necessary. In some communities the company is the best specialized agent to build the houses. The relationship between employee's houses and production can be quickly shown by indicating that the average worker who is working an eight-hour day is only in the plant about one-quarter of the time. Everyone agrees that the conditions in the plant affect the worker's health, and consequently his production. If this is true, how much truer must it therefore be that the conditions in his home will affect production? Furthermore, the costs of changing employees continually, which are an enormous drain on any business, will be largely cut down if the employee can live in a better home while working for a particular company. He will tend to want to remain with that company. The cost of replacing employees may be found to be larger than the interest rates on the money that a company may tie up in an industrial housing project.

Industrial houses may be company owned, may pass into the hands of the worker through the financial assistance of the company in the beginning, or may be owned by a separate corporation which is in turn jointly owned by the employer and employee. The company-owned town is generally undesirable and is likely to result in the abuses that have brought condemnation upon industrial housing in the past. It is far better to be located in a city than to have the workers feel thay are being imposed upon by the company-housing policy. Company houses tend to make a man feel that he is living for, as well as working for, a company. One of the latter two types of ownership of the housing program is more successful, though in any case, in the beginning, the company must manage the town affairs. This town management sometimes proves a heavy burden on the company, and many smaller concerns who have felt that an industrial community of their own would be desirable, and who have

overlooked these municipal responsibilities in their chart of organization, have learned to regret the day they entered into an industrial housing project. However, most such programmes do not involve town management, but merely the addition of housing facilities in a town already organized.

CHAPTER X

PLANT LAYOUT

It is costly to have products which are being manufactured retrace their steps through the factory building. It is also costly to have heavy products worked upon in upper stories to which they must be transported for manufacture and from which they must be brought down after manufacture. Millions of pounds of factory goods are unnecessarily rehandled and are unnecessarily lifted in American factories year after year, because of improper development of the layout of the plant. It is not enough in developing a factory to build a well-constructed plant of brick or concrete and to have it adequately lighted and ventilated. It is necessary that the plant be constructed with direct thought of the way in which it is to be utilized, and with thought of elimination of excess back-tracking of product.

In the Middle West of the United States sections and quarter-sections have always been the basis of ownership of land. Roads have been laid down upon the section lines and have proved very effective means of communication on level ground where the gridiron plan, in the main, worked effectively. In rough country, laying the roads along the quarter-sections has meant that millions of pounds of goods are needlessly hauled over hill after hill on their way to market, and thousands of dollars have been spent each year on repair of hillside roads which became washed out. If the roads had been laid according to the contour of the ground, the peculiar conditions which had to be met in individual localities could best have been provided for. Millions of pounds of factory goods are similarly hauled over hills in the factory year in and year out because the original plan of the building did not take into consideration the processes to be carried on and the needs of the industry.

The modern factory building is so developed that all processes are thoroughly considered and related one to another and to the plot of ground which is available, and then the building is designed to properly house these processes. Thus proper layout is assured, as contrasted to the older idea of endeavoring to fit manufacturing processes into a building already constructed.

Consideration of adequate factory layout readily divides itself into

the selection of the proper size and type of factory building, and then the application to this building of the ideals of layout later discussed.

Factors that influence plant layout. Prior to any effective consideration of either of these main phases of layout, it is essential that thought be given to the type of industry, type of product, type of operation, and type of workers involved. For consideration of layout and many other management purposes industries in general may be well divided into continuous or assembly industries. A continuous industry is one in which the material is all received at one point, from which successive operations turn it into the finished product. For instance, continuous industries are yarn-spinning, paper, and pottery manufacture. An assembly industry is one in which the finished product can be produced only after various components have been made and are ready to be assembled. Thus the manufacture of shoes, clothing, and automobiles are assembly industries. Decisions concerning both the size and type of factory building and the application of layout ideals must be made with reference to this major division.

Furthermore, some continuous industries are synthetic, that is, the product is obtained by bringing together various ingredients which are worked up in manufacture, as paper manufacture or yarn-spinning. Other continuous industries are analytical, that is, the product is obtained by continual processes that separate the final product from the mass of original material. All refining industries, such as oil, by-product coke, etc., are of this nature.

Assembly industries are also of two types: first, those in which the components are similar and go through similar operations, as, for instance, clothing; and second, those in which the components are dissimilar and go through unlike processes, for instance, shoes and automobiles. From the factory-layout standpoint this difference is significant and must be considered, together with the primary fact that in assembly industries there are two main types of operations, namely, those which produce the components and those which assemble the components. Layout must always be developed with all these factors in view, particularly because of the provision for storage space which must be allowed.

The type of product, that is, whether the product be heavy or light, large or small, liquid or solid, is another fundamental consideration. Although the manufacture of spark plugs and locomotives both involve assembly work, layout problems differ materially. Layout problems in any plant where the product can be flowed, either by gravity or pumps, from one operation to another, as in flour or sugar manufacture, differ materially from those in which work in process must be handled by hand or by truck in moving from one operation to the next.

Certain types of operations make imperative that they be considered

first in making layout plans. Such are wet operations, as leather-tanning or textile-dyeing; operations involving heavy machinery, as large hydraulic presses; and operations which involve fire risk, as manufacture of powder or linoleum.

The type of worker is important as a fundamental consideration, particularly in the employment of women workers, where many decisions concerning factory layout must be changed because of the requirements of these employees.

Size and type of factory building. The selection of a given size or type of factory building is dependent on all these considerations, is dependent upon the application of the ideals of layout shortly to be considered, and is also dependent upon the location which has been selected for the factory. Frequently the selection of the plant location will be partly dependent upon factory-layout problems. For instance, if it be determined that a series of small, scattered units is preferable to one large plant, this would most certainly mean that a suburban location would be improper, and that the small plants must be located in various parts of one big city, or should be put out into a number of small towns where cheap labor is available. The decision on the part of a very large enterprise to bring together all their work in one huge plant would be very likely to immediately result in the establishment of an industrial town. Considerations concerning the type of building to be erected, because of fire restrictions, ground space to be occupied, and other similar matters are likewise very likely to affect location. As in the case of most management matters involving policy determination, it will be found that there must be an interplay, an inter-relationship of the factors concerned, and that location, layout, size and type of factory buildings are linked up, each with the other.

Not only are these four phases of the factory housing problem linked up with each other, but they are very closely associated with the problems of organization in the business. A change in the method of housing an enterprise should generally result in necessary changes in the construction of the organization, in order that supervision may be made most effective. Conversely, a change in organization may make it absolutely essential that certain physical aspects of the factory building be modified. For instance, if it is decided to place several departments under the control of one superintendent, it is necessary that these departments be so located that the superintendent may be easily accessible to the foremen of the departments, and that he in turn be able to visit the foremen without the loss of too much valuable time. In one plant, which does not operate elaborate staff departments, and thereby increases the importance of its superintendents accordingly, one of the superintendents has been given control of three departments, doing similar work,

but located in three mills, each about half a mile from the other. It is not difficult to trace the causes of many delays in production; the superintendent cannot be found when he is wanted.

Size and type of building will be seen to be directly related to the establishment of functional departments. If these departments are established they must of necessity be so located as to make possible immediate contact with all portions of the line organization of the business. This is particularly true of planning departments. If staff departments be organized, they may cause the erection of one large plant, so constructed and laid out as to give them complete opportunity for contact. If a number of small buildings should be established, it would mean that effective action from the staff departments would be made more difficult. To have them represented in each of the buildings would probably mean an increase of overhead expenditures, which would be likely to deprive them of the opportunity to cut down production costs with full effect. Or it might happen that the management would decide to adhere more closely to the lines of military organization.

The importance of the factory building as a primary tool with which to carry on production, and into which all other production tools and mechanisms fit, cannot be over-estimated. Like all other tools, the factory building must fit the job to be done if that job is to be done most effectively. Defects in factory building construction are often so primary and organic as to make impossible remedying them after production is begun. Hence they are often of more continuing importance than disorders in other phases of management, which can be made to respond to the treatment of the executives. An ineffective plant creates a burden in all of the daily operations of the business. Thus the modern factory building is far different from its predecessor of not so many years ago, different mainly because it is built to house a given set of operations and given organization conditions, whereas formerly the factory building was put up, and the organization conditions and operations were made to fit as best they could.

How large should a factory be? It has frequently been concluded that the larger a factory grows, the more economies of operation through mere size, can be affected. This idea is probably linked up with the general American concept of hugeness as a goal at which to aim. Merely because there are distinct advantages inherent in large-scale operations does not always mean that such operations must be carried on within the walls of one plant. There are many advantages to be secured by the huge multi-acred plant which has come to be looked upon as typical of the new industrial day. On the other hand, we see everywhere about us, in industries which permit, small plants which are not only able to compete with their huge rivals, but which frequently produce far larger returns per

dollar of invested capital. How is that possible in these days of large-scale production, integration and control of markets of raw material and finished product? The answer lies almost entirely in the management problems involved in operating the large plant and those involved in operating the small plant. The small plant has certain very definite management advantages which are causing managers of large plants to wonder whether there is so much in mere size after all.

In the first place there is a difference in the labor problem in the large plant and the small one. No matter how effective the organization, the development of committees, good executive control, or other lubricants, it is impossible in large plants for the worker to be in actual contact with the men really running the plant. For administrative purposes, workers must be numbered, and must be known on the payroll more by their number than by their name. This is but an evidence of the impersonal contact which is a direct resultant of the growth of huge organizations. Many management devices have been instituted for the single purpose of minimizing this impersonal relationship in so far as it is possible. Small plants can eliminate these devices. The possibility of maintaining close relationship between the head of the organization and the worker, that has passed so largely out of industry with the coming of the big corporation, has not only led to the survival of the small concern in many individual cases, but is causing many managers of big enterprises to pause and ask, " How large should a factory be? " In attempting to answer this question we find some of them actually splitting their producing units, dividing them among several communities, or several sections of the same community.

A recent cause that has led managers to split their producing units has been the feeling that this will enable them to counteract attempts of union organizers to gain control of the workers of the plant. In some cases, as we have seen, the ease with which union control is exercised over workers in large city plants has caused manufacturers to split their working forces and place their manufacturing operations at scattered points throughout small towns within trucking distance of some main assembly or sales center.

Under present economic and industrial conditions times of depression are inevitable and constantly recurrent. This directly influences the problem of size of the plant. Businesses which have several plants are enabled to practically shut down one of these entirely at such times. Businesses that have but one big plant must shut down a portion of that plant. This latter course means that the workers throughout the organization are affected because of the shutdown of one small section of the business. They see other men and women thrown out of work, and they naturally ask, " Aren't we next? " or " Shouldn't we decrease our production so that there will be enough for all of us? " It is true that rumors

may come to plants that are still running concerning other plants of the same company which have been partially or completely shut down, and that this may slightly affect production in an unavoidable way; nevertheless the effect is far different from the shutdown of a portion of the same factory. In the latter case the workers who remain knew large numbers of the workers who were laid off, the whole action is so close that they necessarily feel that they are "next." The net effect is that the business is more affected by the depression on account of the higher production costs.

One large manufacturing concern has recently decided on a policy of a number of small plants instead of one huge one, largely on the basis of the resale value of their buildings. They have felt that conditions in their particular industry are likely to change so much within the next ten or fifteen years that any building which they might put up for themselves to-day would be entirely out of date at the time. They have felt that the resale value of a number of small plants would be far larger than the resale value of one large plant, specially constructed for their particular needs. Acting on this one basis, they have vetoed the one large plant idea. This may be a special case, but it indicates how broad are the considerations which management must keep in mind when deciding on the selection or erection of a plant.

Industries manufacturing large or heavy products with nation-wide distribution are always face to face with the freight rate disadvantages inherent in one large plant, no matter how central its location may be. One of the best examples of a method of coping with this problem, and one that has been largely followed, is that of the Ford organization. The idea of assembly plants in many parts of the United States, with the product shipped to them from the main factory in knocked-down condition, and the consequent saving of the freight involved, proved so successful that it was not long before the example was followed by other automobile concerns and by other lines of industry. An example of this idea in other lines of industry is to be found in the utilization of "fabricating shops" by steel manufacturers. More or less rough shapes are shipped to locations near the big cities or other centers of consumption, and are there worked over, or "fabricated" in accordance with the needs of the local community. In this way, not only are freight rates saved because more pounds of steel can be put in one freight car, but the operations of the mill become more standardized and management problems correspondingly decreased. The diverse operations of fabricating are left to the fabricating, or what practically amount to assembling, plants in their scattered locations.

The small-department idea. Many plants which feel they are unable to adopt the small-plant idea, or which feel that the benefits of the large

plant outweigh these, have adopted the small-department idea. This idea must also be either accepted or rejected before the plans for the layout of the factory building are decided upon. The small-department idea merely involves the setting of a limit beyond which a given department in a concern shall not be allowed to grow. When the need arises for the growth of that type of work beyond the limit set, there is created another department, under the same roof, performing the same functions, but under different supervision. Some businesses claim that they have found the point in their processes beyond which it is difficult, if not impossible, to carry on adequate supervision. These plants say that one foreman, or superintendent, cannot carry the details of operation of more than a certain number of machines, a certain number of operators, or a certain number of units of product in mind. They say that no matter how much you may allow him to delegate his responsibility, the fact remains that he is responsible for more work (not necessarily more functions) than he can handle. Therefore they have split their similar operations into several departments, each of which is under the control of different foremen, whose relationship to the remainder of the factory organization is exactly the same as if the work being carried on under their respective supervision were of an entirely different nature. The element of competition between like departments is a valued feature of this plan. If this type of organization is to be effective, it is essential that the departments performing similar work be physically separated one from the other.

Type of building. Closely linked up with problems of size of buildings are problems of type, particularly as to whether the buildings should be one story high or should be multistory. One of the first thoughts with reference to the proper number of stories is the convenience of keeping several processes within one building, but distinct from one another.

The lowest cost per square foot of floor space can usually be secured through the use of three- and four-story structures in cases where the ground is valuable. Otherwise the lowest cost is likely to be found in two-story buildings. With the addition of stories above four or five on a building, the cost per square foot is likely to increase rapidly, because of the large space that will be occupied by the service features, such as stairways, elevators, and fire towers, as well as the cost of the better foundations that will be required. The repair charges incident to machinery operating on various floors at various speeds and rhythms must also be taken into account.

Many managers have inclined toward the suburban location because there they can establish a one-story shop. They feel that they can secure better light and ventilation in the one-story structure. One element of cost that is reduced, particularly in plants that use heavy machinery, is

Courtesy Proctor & Schwartz.

FIG. 13.—A One-Story, Saw-Tooth Building, Proctor & Schwartz, Olney, Philadelphia, Pa.

the cost of foundations for the machinery. Furthermore, the vibrations from operating machinery, which are a large element of cost in maintaining proper alignment of shafting, are practically eliminated, the machinery being set directly on the ground. Materials are more easily handled in the one-story building, as their elevation, particularly in the case of heavy goods, is expensive. The elimination of supports for upper stories not only gives more floor space, but makes it possible to lay out the shop entirely from the point of view of the needs of the plant, without regard to restrictions imposed by strains and stresses from upper floors. This allows a temporary and less costly type of partition to be installed, which may be changed as the needs of the business dictate. Some departments grow more rapidly than others, and this growth cannot usually be foreseen. With light goods, or goods that

can be moved by gravity, the advantages of the one-story building are eliminated. A cost analysis will usually indicate that with light machines and a light product, regardless of the value of the ground, multistory buildings are advantageous.

Ideals of layout. In developing the actual layout of a particular plant there are certain ideals of good layout which must be continually kept in mind, although their modification to suit particular conditions is always necessary. These ideals are: proper balance of departments and operations, development of production centers, direct line layout, short moves, adequate internal transportation, development of service centers, and provision for future expansion.

Proper balance of departments. Proper balance of departments or operations provides for the elimination of limiting or bottle-neck operations within the plant. It is essential that the capacity of each department or of each machine working on each operation be sufficient to properly take up the production of prior operations and to transmit to following operations sufficient product to keep the equipment there fully utilized. Any other plan involves increased inventories of material in process, overtime work, with its attendant increased costs, and general confusion, including utilization of expensive factory floor space for material tied up while in process. In one textile plant it was found, after investigation, that the beaming operation was only able to supply a warp to approximately 450 looms, while there were 500 looms in the plant. It can readily be seen that this involved excess equipment charges on 50 looms, or operating the beaming department overtime, which, in this case, was difficult because of union regulations. The provision of proper balance of departments indicates the necessity of close analysis of all operations to be performed prior to the development of the layout.

Development of production centers. Production centers, rather than workplaces, should be provided within the departments. Instead of considering the worker and his machine the unit for which space must be provided, each worker tending a group of machines or each machine tended by a group of workers should be looked upon as a production center. The production center should include the workmen, the machines, space for storage of raw material and completed units from the operation, supplementary apparatus of any kind needed in the performance of the operation, and a share of the aisle space required between that production center and the next.

Direct line layout. Direct line layout implies the processing of the product in one direction or in one logical series of directions from start to finish, with a minimum of retraced steps or backward movements. The attainment of this idea is complicated by the following factors, particularly in assembly industries:

1. The use of the same machine on more than one operation in the process. It may be inadvisable to erect two machines, particularly if one operation will not keep one machine continuously employed.
2. The performance of two or more operations by the same worker, as in felling operations in the clothing industry. Where each part moves quickly and is easy to handle, it may prove cheaper to move the material than to move the man.
3. The necessity of placing all operations in the production line with reference to the peculiar considerations already enumerated, such as the type of product or operation. Thus, many operations must have special light, such as cloth-examining in clothing plants, or wool-sorting in woolen yarn plants, where the light must come from the north. Tanning vats in tanneries must be placed on solid ground because of their weight and the wetness of the operation. Spray varnishing must be so located as to provide for effective ventilation.

Thus, in striving for direct line layout, continuous compromise of the ideal is often necessary when facing particular conditions. Direct line layout is applicable either to a particular floor of the factory or to the building as a whole. The accompanying illustration (Fig. 14) of the layout at the assembly plant of the Ford Motor Company, in Philadelphia, indicates the way in which the direct line principle may be applied to departments of a plant and to operations within that department.

The advantages that accrue from moving the product in a straight line are numerous, among which the following may be mentioned. The speed of production is increased, the cost of conveying and trucking within the factory is reduced, there is secured a minimum of noise and confusion within the plant, and there is a minimum of distraction because workmen are not journeying to and fro.

Short moves. The layout should be planned so that the transportation of the material from one work center to another involves as short a move as possible. However, it has been proved the poorest kind of policy to save space in a factory at the expense of men or materials. Many managers have made the mistake of crowding the operatives, only to find that the subsequent loss of production per worker was far more costly than a comfortable layout would have been. Short moves are an extremely important factor where the product is heavy and unwieldly and where the handling cost is a large factor in the expense, as in a steel fabricating plant. Crowding of workers must be interpreted in the light of duties to be performed and operation methods. Thus, on continuous assembly lines, as in the Ford Motor Company plant, workers may be placed close

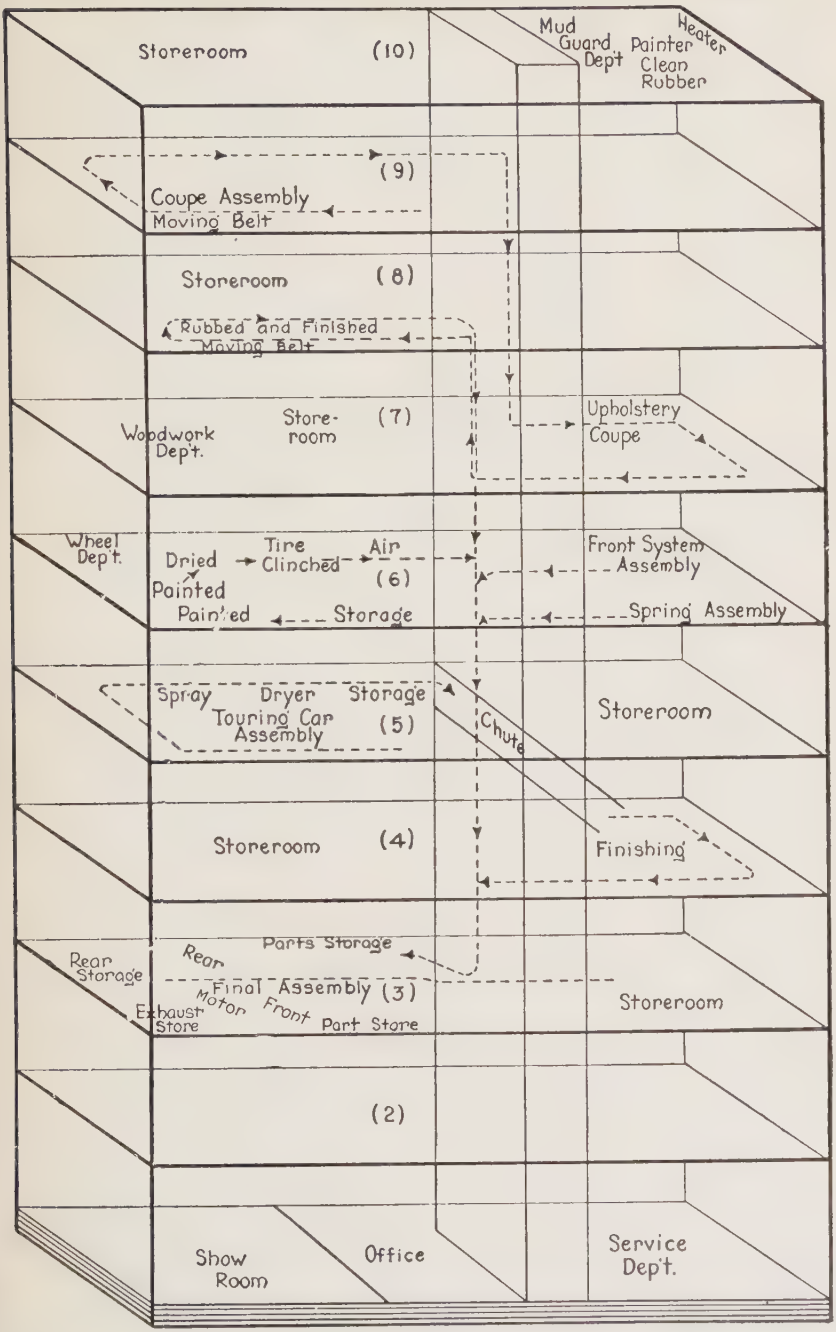
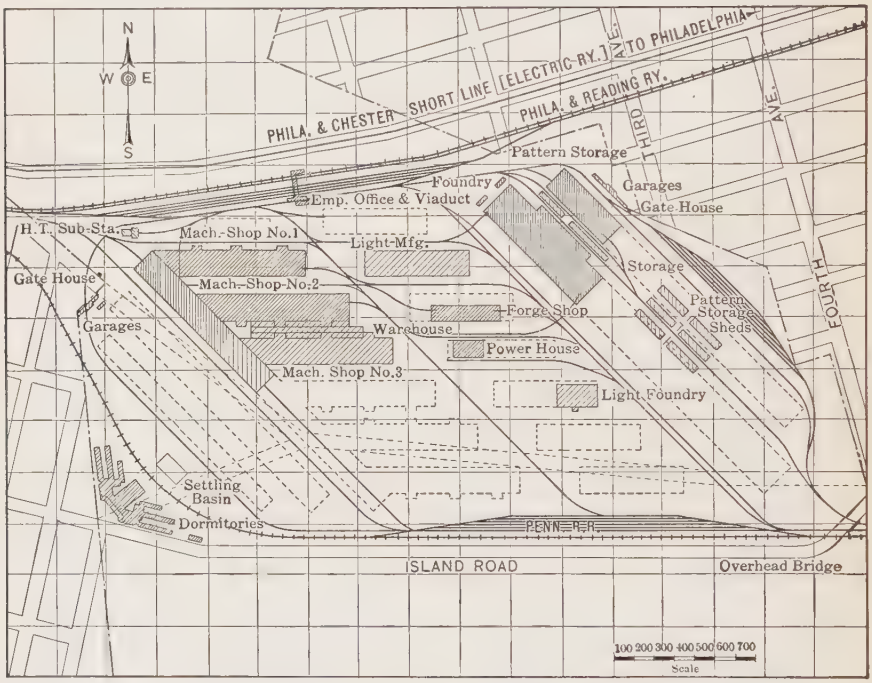

LAYOUT - FORD MOTOR COMPANY - PHILA. ASSEMBLY PLANT - OCT., 1922.
Storeroom (10)
Mud Guard Dept
Painter Clean Rubber
Heater
(9)
Coupe Assembly
Moving Belt
Storeroom (8)
Rubbed and Finished
Moving Belt
Woodwork Dep't.
Store-room (7)
Upholstery
Coupe
Wheel Dep't.
Dried
Painted
Tire Clinched
Air
(6)
Pain'ed
Storage
Front System Assembly
Spring Assembly
Spray
Dryer
Storage
Touring Car Assembly (5)
Chute
Storeroom
Storeroom (4)
Finishing
Rear Storage
Rear
Parts Storage
Final Assembly (3)
Motor
Front
Part Store
Exhaust Store
Storeroom
(2)
Show Room
Office
Service Dep't.

FIG. 14.

together, since material disposition and type of work to be done permit this.

Adequate internal transportation. The first and most important factor connected with adequate internal transportation is adequate aisle space. This must be amply sufficient for all trucking requirements, and must be kept clear, possibly by painting white lines upon the floor. Main aisles must be considered separately from the space allowed when figuring production centers.



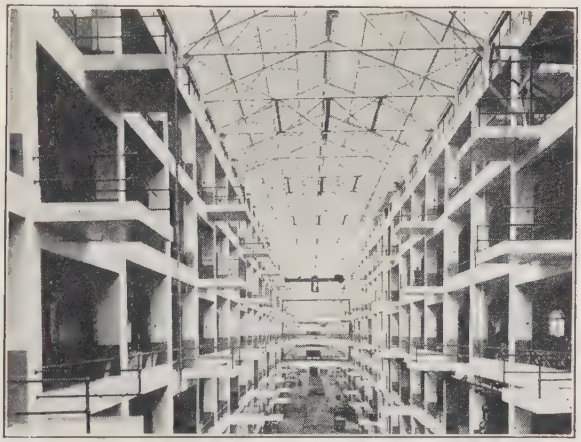
Courtesy Westinghouse Elec. & Mfg. Co.

FIG. 15.—Layout of Westinghouse Electric & Manufacturing Co., South Philadelphia Plant, Lester, Pa.

Layout is directly affected by the newer methods of inside shop transportation, such as gravity chutes, traveling hoists, and belt or link conveyors. These devices may be used alone or to meet outside transportation facilities. In plants where the layout, because of peculiar situations, cannot conform to a straight line, the best possible use of inside transportation is an exceedingly important factor, and may be the basic factor from which the others are determined. Examples of this are to be found in the Gary plant of the United States Steel Corporation, or the South Philadelphia Plant of the Westinghouse Electric and Manufacturing Company. Inasmuch as the product is moved frequently on railroad

cars, the layout of both of these plants is largely based on the proper curves of the railroad tracks. The angles between bays of the building are such that easy curves are provided, as is indicated in Fig. 15.

Needless to say, mechanical conveyors or gravity should be used wherever possible in the processing. When the study of the routing is being made every possible place for such handling should be carefully considered and the various types of mechanism or structure should be thoroughly investigated. The handling cost of materials is often a very important factor in the cost of the product, and every practical device or mechanism should be employed to reduce this cost. Many factories expedite the trucking of materials by the use of inclined runways instead of stairs. Frequently a belt or roller conveyor can be used to carry the material from



Courtesy David Lupton's Sons Co.

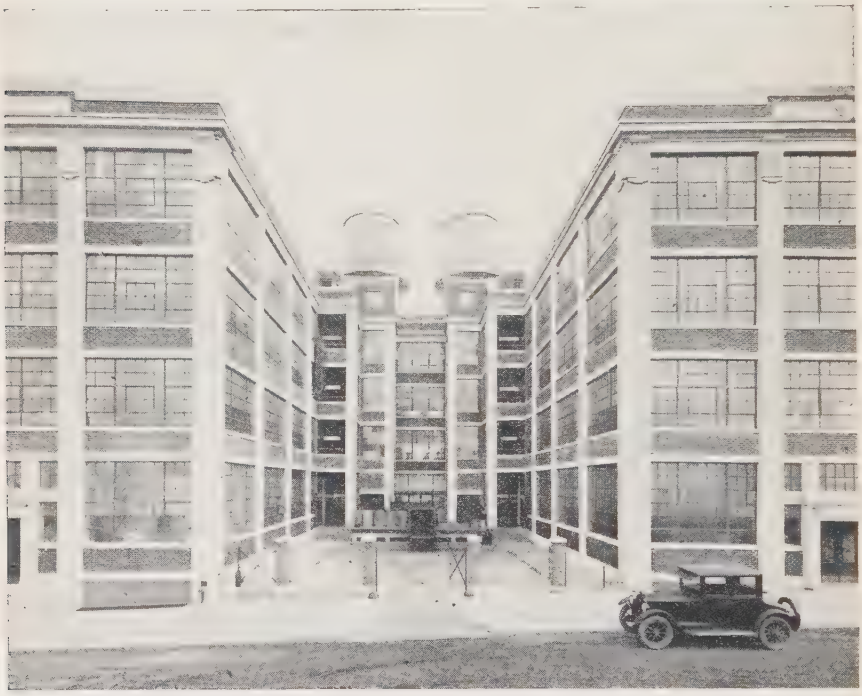
FIG. 16.—Interior Ford Motor Company, Highland Park, Mich.

one place to another and in still other cases gravity, the cheapest conveyor of them all, can be used. An example of this will be found at the Victor Talking Machine Company plant at Camden, N. J., where gravity conveyors transport finished records fully a city block.

An outstanding instance of effective internal transportation is found at the Ford Motor Company plant at Highland Park, Michigan. Figure 16 shows one of the service bays of this plant. Material can be taken from a freight car on the ground floor and deposited by crane on any one of the landing platforms on any of the other floors. This scheme brings the various portions of this huge plant into close contact.

Development of service centers. By service centers are meant the tool, stores, dressing, and rest rooms that form a necessary part of every plant. These centers should be convenient to the actual processes but

should not obtrude upon them to the hindrance of production. The shorter the distance from the operations to these centers, the less time will be consumed by workers going to and from the workplaces. It is advisable to place the rest rooms separately from the locker and dressing rooms where possible, particularly where women workers are involved. As a rule, the service centers should be in those parts of the premises where the light is least desirable. Frequently, it has been found possible to place the service centers on balconies between floors. This is naturally



Courtesy Notaseme Hosiery Co.

FIG. 17.—Plant of the Notaseme Hosiery Company, Philadelphia, Pa.

a big space-saver as well as a convenient arrangement as regards proximity to the processes. Another good arrangement for these centers is to place them in divisions of the process or in natural divisions between buildings or parts of the same building. This tends to bring these centers into close proximity to the entrances, exits, and elevators. An example of this is shown in the accompanying illustrations of the plant of the Notaseme Hosiery Company, Philadelphia (Figs. 17, 18). It will be noted that all service centers in this plant are located in the cross-section of the U of the building. They are thus equally distant from both sides of the production

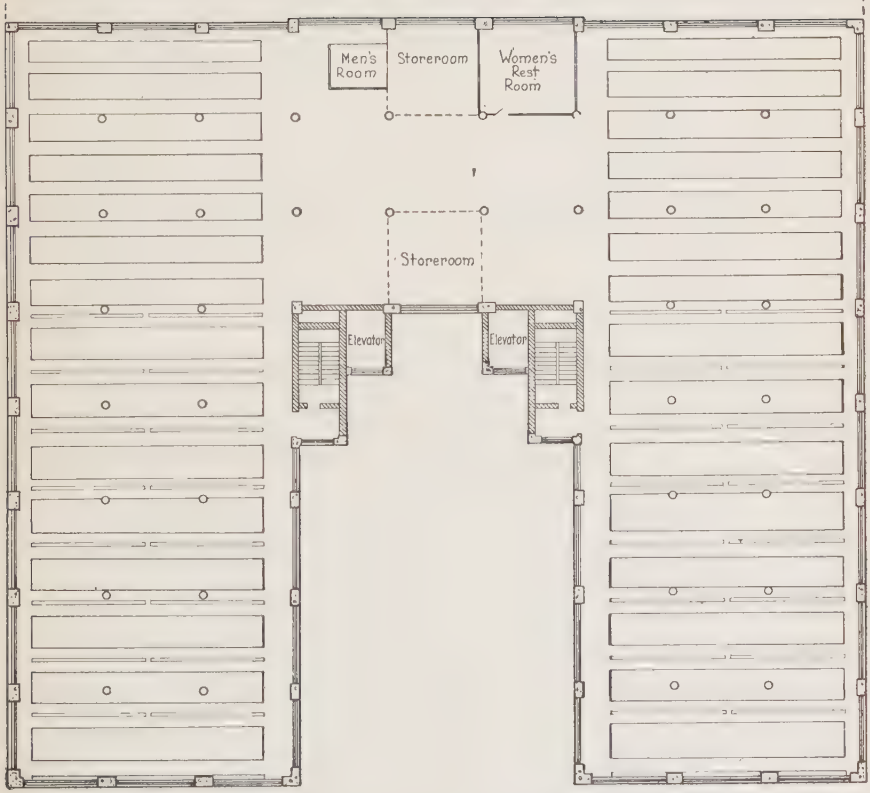


FIG. 18.—Floor Plan, Notaseme Hosiery Co., Philadelphia, Pa.

floor and are further conveniently located, since receiving and shipping is from the central court of the building.

Provision for future expansion. Figure 18 further illustrates the possibility of developing the layout so as to provide for future expansion. This building, which is developed along the lines of the letter U, can be readily expanded by extension of two wings in a way that will form the letter H. In this expansion, the service centers will still remain centrally located. It may be that because of peculiar conditions, expansion must take the form of additional buildings. However, in such a case, a definite building plan should be followed in the first place so that accretions will be reasonably easy to make. However, if a new building is being constructed for an exterprise, the original plans can ordinarily be made for a type of structure that can be readily expanded. Logical enlargements may be made to buildings constructed along the so-called U, L, H, T, or E types as indicated in Fig. 19.

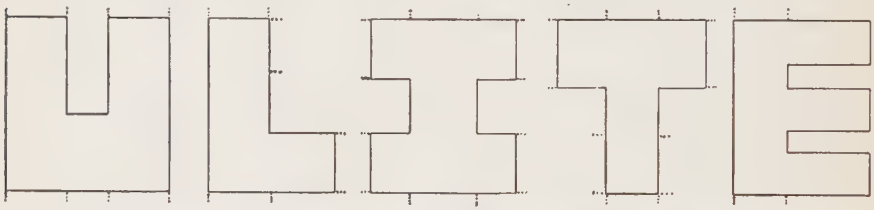


FIG. 19.—Ground Plans of Industrial Buildings Indicating Possible Directions of Expansion.

In multistory buildings frequently the original building is put up with a view to taking care of increased production at a later time. In such cases fast-growing departments ordinarily should not be located on the top floors or bottom floors of the building. Additional space is easier to secure properly if the fast-growing departments are placed somewhere in the middle of the building.

Making the layout. In making the actual layout for a plant it is most important to have complete information at hand before the layout is made. By this is meant all such information as size of production centers, size of storerooms needed for raw materials, partly finished and finished products, space needed for tool rooms, auxiliary equipment, office and production department requirements, aisle space, recreation rooms, service centers, boiler and engine-room requirements, and all other similar departments or facilities requiring space. Every required square yard of space must be estimated before final plans are prepared. Future expansion must always be borne in mind and provision made for it. A frequent mistake is that of not providing for expansion or not providing enough space to really fill future needs. Mr. Keppele Hall, a well-known manage-

ment engineer, says of planning floor space, " Figure on the basis of your greatest possible needs; then double the figure arrived at and you will just about know the amount of space needed." Mr. Hall did not mean this to be taken literally, of course, but it is indicative of the spirit with which the layout of space must be attacked. It is, of course, necessary to know the exact sequence of operations on the product and those operations which require special consideration, such as better light or better ventilation.

With such detailed knowledge at hand, together with a recollection of the ideals for plant layout, and with the building construction expert always available for consultation, the actual layout may be proceeded with. An excellent way is to make, of cardboard or paper, small, scaled templets representing each machine or group of machines in the process. These should be laid on an outline plan of the building drawn to the same scale. By this means the almost invariable changes and shifts in plan may be made without expensive and time-wasting drafting work. These shifts are necessary in almost every case. It is best to proceed very cautiously, looking at all times for the unexpected difficulties. The tendency to forget the aisleways and floor storage spaces is great. The location of the templets on the floor plans is frequently based on an aisleway which has been determined upon and definitely laid out with proper relation to the stairways, elevators, or runways. When the templets are completed and approved, the whole may be transcribed to blue prints.

CHAPTER XI

INDUSTRIAL LIGHTING

Modern management differs from that of twenty years ago in many ways, but in none more than in the method of lighting the workplace. The spread of the doctrine of good lighting has been accompanied by enormous strides in the development of lights and lighting fixtures until the lighting of industrial buildings has been revolutionized. Practically all factory executives recognize the necessity for good lighting, but the number who have gone more deeply into the subject, so as to discover what good lighting really is and how it may be secured, is fewer. It has been too easy for the lighting-equipment salesman to sell his wares merely because they represent some new device or because he talks well. This has resulted in many inefficient and, in some cases, actually harmful installations where the desires of the manager have been the best.

Good lighting is necessary, not only from the production standpoint, but from the social standpoint. Since the modern industrial system forces so large a percentage of the community to utilize their eyes on close work, it becomes essential, from the standpoint of the health of the community, that there shall be some action taken to regulate lighting conditions in industry. Thus we find that all the more progressive states, including practically all the states with large manufactures, have laid down regulations for factory lighting. These regulations establish certain minimum lighting standards for factories and other workplaces. In many cases it has been found by the manager that he cannot always rely on the state standards, but must ascertain his own needs, and use the state standard as the minimum, only, below which he cannot fall.

Results of defective lighting. The results of defective lighting are numerous and rather easy to definitely ascertain. The cost of installing proper lighting is small. Oftentimes the cost of operating a defective lighting system is larger than the cost of operating a proper system. At any rate, the total cost of operating a good lighting system will seldom be over 1 per cent of the productive wages, and this is a small addition to overhead expenses. It has been estimated that if a workman is hindered for one minute in an hour by defective illumination, the resultant loss will be sufficient to pay the complete cost for lighting his workplace for the hour. The following specific examples will illustrate this. At the

Schenectady shops of the General Electric Company in one instance the bettering of illumination in a section devoted to semiautomatic buffing increased production 8.5 per cent. The increased cost of lighting amounted to 0.4 per cent of the increased value of production. A machine shop in Chicago, by increasing the illumination so that the increase of lighting cost amounted to 1.2 per cent of the payroll, gained an increase in production of 10 per cent.

Defective illumination results in a dollars-and-cents loss to the business in at least five ways: in accidents, loss of production, spoilage, effect on the general character of the workplace, and in the future capacity of the worker. The effects of poor illumination on the accident rate are too apparent to need much explanation. Failure to see dangers and failure to properly estimate their distance are both chargeable to defective illumination. A survey of 91,000 industrial accidents in 1910 from the records of the Travelers' Insurance Company showed that 23.8 per cent of these accidents were attributable to improper or inadequate illumination. Although there has been no exact survey since, this company now charges only 15 per cent of industrial accidents to this cause, due to the general improvement in lighting conditions.

Actual decrease of production is the second direct result of poor illumination. The illustrations already given bear out the general estimate that poor illumination will result in a decrease of about 10 per cent in the productive capacity of the worker. This is due to fatigue attendant on eye-strain, and the resultant decrease in the productive "push." In addition to the quantity-production decrease attendant on defective illumination we find a decrease in the quality of production to be most usual. In some portions of the cotton-goods trade, particularly in England, cotton goods made in summer have demanded higher prices than winter goods, their quality being superior because of the better lighting conditions. Where the fine scales of micrometers must be read during production, lack of light is a frequent cause of slowing up production and perhaps of spoilage.

Defective lighting conditions increase the amount of spoilage. Experience and observation seem to indicate that of the huge amount of material spoiled in American factories, 75 per cent occurs during the time that artificial light is in use. Putting it another way, 75 per cent of the factory spoilage seems to occur during 15 per cent of the working year. Doubtless there are other factors which influence this loss besides the bad lighting, but apparently the large part of this loss could be prevented by providing conditions during the after-dark hours which approximate those prevailing during the remainder of the day. This, of course, applies to plants which have good daytime, but poor artificial lighting. In many plants the reverse is the case. In fact there are cases where the workmen have

requested to be put on night work, for, when working on piece rates, they could make more money under the better lighting conditions prevailing after dark.

The general character of the workplace, for instance, its cleanliness, has a direct result on the production that is secured. Good lighting has a direct effect on the cleanliness of the workplace and its maintenance in general all-round good condition. As a rule a dark shop is also a dirty shop, a light shop is usually a clean shop. There is nothing so bad for dirt as plenty of light. Light, and especially sunlight, has a direct influence upon the destruction of various bacterial organisms, especially tubercle bacilli. Moreover, there is an undoubted psychological effect of plenty of light in a factory upon the cheerfulness and well-being of the workers.

The last result of defective lighting that will be mentioned is the decrease in the future capacity of the worker. This is more intangible than the direct results mentioned, but is nevertheless just as real and in many respects more important. It is this result of defective lighting that furnishes the chief ground for state action. By driving workers under one of the many systems used to get immediate production, it may be possible for a plant temporarily to get full production from its workers with ineffective lighting. If the plant is lucky, it may have few accidents. When the worker's sight begins to fail, and the ills attendant to eye-strain begin to make themselves felt, the plant may then drop the worker from its payroll because of his inability to produce. It may thereby add some slight expense to itself, but it saddles a larger and more important expense on the community.

The effect of poor lighting on future capacity is felt in two ways—failing eyesight and general failure of health. Failing eyesight may take the form of mere decrease in the vision, or it may be that the defective lighting will cause eye diseases, such as the formation of cataracts. For instance, workers on white goods, engravers, steel-makers, and others in similar occupations who work on materials reflecting glare, frequently suffer from eye lesions or the formation of cataracts. Headaches, backaches, anaemia, and other defects in the general health of employees are directly traceable to defective illumination. Of course, poor illumination is usually only one of several poor factory conditions which cause this decrease in general health, and therefore it is very difficult to trace the exact effect of poor lighting in this connection.

With all these results of poor lighting in mind, let us see what the factory manager can "do about it." In the first place it will be well to point out that this is one of the steps in installing good management in which he will receive no opposition. Workers, union or non-union, will not complain against the bettering of conditions in the factory. Inasmuch as the resulting increase in production is likely to be more or less auto-

matic, there will be little complaint on that score, except possibly from some union men, when the top limits of production have been dogmatically set by them, and when greater production will not be secured, regardless of working conditions.

Effective use of natural light. The first step toward securing proper lighting conditions is to provide proper natural lighting during the daylight hours. To provide good artificial lighting, if the natural light be poor, will solve but a portion of the problem. Natural light illuminates either by direct rays or by reflection from various surfaces outside or inside the factory buildings. Provision for natural lighting must take into account these reflections. The illumination given by daylight is general in that it is spread throughout the whole room. The color of natural light is pleasant for the eyes, and the only disadvantages of daylight are that it is not always uniform, that its intensity depends on seasons, time of the day, and conditions of the weather, that it is difficult to increase the amount of light available for local conditions and on special materials where greater intensity of light is necessary, and that the direct rays of the sun sometimes give too much glare.

The provision of adequate natural lighting is directly related to the construction of the building itself. It is affected by such considerations as the nearness, character, and color of adjoining buildings, the height and width of the individual rooms, the provision of open courts in the layout of the plant, and the type of construction, in so far as that affects the amount of window space that can be secured. The nature of the adjoining buildings cannot usually be changed, and this is one reason why the suburban location may be preferred. However, the other factors can be modified by the manager. The amount of light in the interior of a room will largely depend on the relationship of the height of the room to its width and depth. The rays of light coming through the window fall at an angle, and reach only a certain distance from the window. If the depth or width of the room is too great, a large part of the room will not be reached by the rays coming through the window, and may remain wholly or partly dark. The height of the room is also of importance, because the higher the room is, the greater will be the quantity of light admitted, provided the top of the window is near the ceiling.

It is evident that industrial establishments should have as large a window space as is possible. It has been found that poor lighting will result if the ratio of floor space to window space is greater than six to one. In most modern "daylight" factories the window space will be found to be from one-third to one-fifth as large as the floor space. Such buildings are illustrated in Figs. 20 and 21. Window space on southern exposures sometimes leads to great heat in summer through direct rays, and this must be handled through some treatment of the window glass. Daylight

factories have swept into universal favor, not solely because of their light-giving qualities, but largely because steel windows have become cheaper than walls. This has meant that special consideration must be given in summer to the problem of heat, and, throughout the year, to problems of lighting created by the direct rays of the sun.

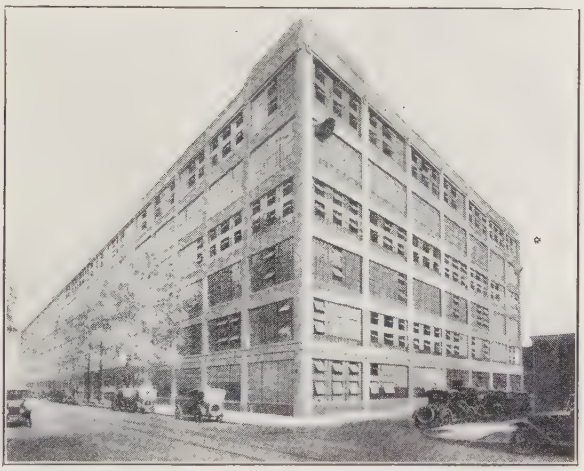
One of the earliest means of providing sufficient natural light was by utilizing the "saw-tooth" roof for one-story structures. (See Fig. 13.) This was not ordinarily applied to top floors of multistory buildings and fell

Courtesy David Luptons' Sons Co.

FIG. 20.—A Daylight Factory, Firestone Tire & Rubber Co., Mechanical Building, Akron, Ohio.

somewhat into disrepute because of difficulties of heating and ventilation which accompanied early saw-tooth roof installations. Newer factories began to "daylight" their buildings through the use of steel window sash which occupied nearly the whole sidewall of the building. Steel windows can be easily adjusted to distribute fresh air and daylight to the interior of the building, they can be made fire-resisting by the use of fire-glass, and they present straight lines which are architectually correct for the industrial building of to-day. They are effective in nearly every particular. Originally they were not air-tight and made winter heating difficult, but this has been overcome. Still, a glass-side factory will not resist penetration

of cold to the extent that thicker walls will. At present many factories are combining the use of steel-frame windows with top-floor saw-tooth roofs or adaptations of these. Thus the B. F. Goodrich Company of Akron, Ohio, has a large assembly room in their rubber shoe plant located on the top floor under excellent top light as well as side light, while those operations which do not require such excellent light have been placed on the lower floors. Fourteen 70-foot lines of window lights in this roof and three 140-foot lines are operated simultaneously by electric control. Ventilation difficulties with saw-tooth roof construction have been overcome in newer types of this roof and also by the use of the double saw-tooth roof with window space in two sides instead of one.



Courtesy David Luptons' Sons Co.

FIG. 21.—One of the Daylight Factories of the Fisher Body Corp., Detroit, Mich.

Figure 22 shows the interior of the double saw-tooth foundry of the Cleveland Co-operative Stove Company, clearly indicating the effective lighting and ventilation of this plant.

The kind of window glass is also an important factor in the development of the natural lighting system. It has been found that the loss of light through ordinary sheet glass is about 4 per cent. Ribbed glass causes the loss of about twice as much light, but this loss is counterbalanced because the rays of light, instead of falling directly on the floor, may be refracted and directed more nearly horizontally further into the interior of the room. This type of glass also has the added advantage of making it impossible for the worker to secure entertainment by gazing out of the windows. Some factories have attempted to gain this latter result, and also to cut off the direct rays, through coating plain glass with

some sort of paint. While this is effective on bright days, there is usually not sufficient light on dull days, since this coating will cause an average loss of 30 per cent of the light.

Proper attention given to the painting of the interior of the factory building will give as good results as attention given to the windows. It is only within recent years that any attention has been paid to the painting of the factory building. Formerly it received a coat of paint at the time of its construction, which was generally supposed to last throughout its life. At times it did not receive even this first coat. Now the modern factory sees that its maintenance staff takes care of the painting of the walls and ceilings in the same way that it keeps any of the machinery in condition.

Courtesy David Luptons' Sons Co.

FIG. 22.—Interior of Foundry, Cleveland Co-operative Stove Co., Cleveland, Ohio.

A paint will reflect or absorb light, depending upon its color and its quality. Flat-tone paints will absorb, while enamel paints will reflect. It is not always wise to have too much reflection, and many of the large paint companies are to-day putting out special interior factory paints which strike the desired medium. The reflection factor in paint varies with the color and the shade. For instance, dark gray paints reflect from 18 to 40 per cent of the light which strikes them, light blues only about 25 per cent, light green about 40 per cent, and white and very light gray 70 per cent and above. Many plants mix some green or blue with their white in applying the paint, in order that the reflection factor shall be reduced to the point of elimination of glare.

The natural lighting problem, except for the painting of interiors or for the provision of minor changes, is one that is largely settled at the

time the factory is built. On the other hand, the artificial lighting problem is one that may be solved long after the factory is built, and, in fact is many times largely dependent upon the type of natural lighting in the factory. Artificial light must be provided to supplement natural light in places where the latter is insufficient, to provide for lighting after dark during regular working hours in winter, for night work, and for outdoor lighting at night.

Importance of artificial light. As a continuous supplement to daylight, artificial light does not present a problem separate at all from the one presented by its other uses. Under present conditions, practically every manufacturing plant in the country is necessarily operated a considerable time, taking the year as a whole, during non-daylight hours. Leaving out of consideration those industries which, from their nature, necessitate continuous operations, like the blast furnace, the hours requiring artificial lighting amount to about 480 a year, or about 20 per cent of the total time. If the decrease in productive efficiency only be considered, and this be taken as 10 per cent, this means a loss amounting to nine minutes of effective time daily, or a total of about five days each year for each person employed. If this is multiplied by the average wage and then by the number employed, it will readily be seen that the cost of installing proper lighting is small by comparison. Night work is profitable only if the lighting is good. Otherwise the production is so low and the spoilage so high as to make it extremely unprofitable.

Outdoor lighting around industrial plants at night is an important factor in cutting down the accident cost around yards. In yardwork, the accident roll is 100 per cent larger at night than in the daytime, and this is entirely due to defective lighting. Modern exterior lighting has recently taken the form of the use of flood light, rather than installations which illuminate only their immediate vicinity. Flood light protects the property, by making it easier to guard, as well as providing the necessary light to work by.

Intensity of illumination. Lighting installations can only be said to be sufficient or insufficient in the quantity of light that they give if they are actually measured. Light is measured by the unit called the "foot candle." A foot candle is that unit of illumination intensity which is equal to the direct illumination given by a standard candle when placed one foot from the object illuminated. Foot candles can be measured at any point by the use of a device known as the foot-candle meter.

The amount of illumination intensity which is needed in a given case varies with at least four factors, the type of the business, the type of the operation, the type of material being worked on, and the type of environment. In general the following figures represent a rough estimate of the intensity necessary in various types of businesses:

	Foot Candles
Rough manufacturing, such as filter-presses and grinding rooms in potteries, vat-rooms in tanneries, rough forging, beating in paper mills, etc	3 to 5
Medium manufacturing, such as rough machining, making light-colored paper boxes, core making in foundries, etc.	4 to 8
Fine manufacturing, such as automatic machines, spinning, weaving, fine assembling	6 to 12
Very fine manufacturing, such as watch manufacturing, linotype operation, inspecting and sorting dark material	10 and up

Boiler rooms, halls, passageways, and other similar places which require illumination, but where actual manufacturing is not carried on, will usually require from 1 to 3 foot candles of illumination. General office work demands around 10 foot candles, while drafting rooms demand 15.

As distinct from the type of business, the amount of light needed will vary with the type of operation. It will be noted that the foot candles required above vary in the same type of business. Work can be divided into two broad classes for the purposes of this discussion, namely, inspective or detective. The first refers to work which entails continuous application of the eye to one point or small area, the second, to work which consists merely of keeping general watch over a given process, actual labor being required only when some fault occurs. Thus in a cotton mill, spinning may be detective in character, while weaving may be inspective, particularly if the pattern be fancy.

The material which is being worked on has a direct relation to the amount of light needed. Light and dark textiles fall into entirely separate groups, although the operations upon them would be the same in either case. Dark and rough surfaces absorb much more and reflect much less light than do smooth, light ones. Similarly, the amount of light required will be affected by the machinery that is used. Machinery that is painted black will absorb a great amount of light. Machinery that is painted gray will not cause undue reflection of light where it is not wanted, and at the same time will not absorb nearly so much light. The difference in a machine shop with many machines if the machinery is painted gray rather than black is quickly noticeable, and black-painted machinery is rapidly passing. Another part of the equipment which has much to do with the intensity of light and means of diffusion, is the power equipment. The type of drive that is employed, that is, whether the drive is group or individual, will materially affect the kind of lighting used. Belts and pulleys interfere with illumination and cause shadows which it is difficult to avoid, whereas with individual drive the upper portion of the room is much more clear and proper illumination is made far more simple.

Requirements of effective artificial illumination. The intensity of illumination, while one important factor of proper artificial illumination,

is by no means the only one. It is possible to have sufficient illuminating power in the space that is illuminated, and still have lighting conditions which will bring with them all the evils of poor lighting. The lighting should also include the following elements, to be a complete success: the color should be as close as possible to that of daylight; it should be diffused uniformly, that is, there should be no dark spots or shadows; there should be an entire absence of glare; and the light should be safe and discharge as few impurities into the air as possible.

Much has been said about the fact that artificial light should approximate daylight, in so far as that is possible. In the endeavor to carry out this principle, many factory managers have arranged their artificial light so that it will fall upon the work from the same direction as the daylight falls. Inability to control the source is one of the most serious defects of natural light. The result has been that a bad condition was intensified, when it might have been corrected for a portion of the day through the better arrangement of the artificial lighting. However, it is considered excellent practice to have the artificial light as near the color of daylight as possible. This is not always practicable, inasmuch as the advantages of installations where the color is different from daylight oftentimes outweigh those of the daylight-like installations. Illustrative of this is the fact that the flaming arc light is as near an approach to daylight as has yet been found; but because of its cost and difficulty of control it is but seldom used in the interior lighting of industrial plants.

Uniform diffusion of the light is more important, and ranks with sufficient intensity as one of the prime essentials of proper lighting. The measure of effectiveness of a lighting system is not the brilliance of the source, nor of the object illuminated; but the ability of the worker to distinguish clearly and differentiate easily without eye strain. Extreme brilliance improperly diffused only tends to tire and confuse the vision. The essentials in this respect are the avoidance of irritating brilliancy or obscurity, the confusing shadows of which are usually a result of the former condition. This means that all portions of the room must be illuminated, that there cannot be any dark spots which the eye will see and contrast to the brilliant spots where light falls.

The absence of glare is the third and final of the more important requisites of proper artificial illumination. Glare is of two kinds, glare from the source of light and glare from reflection. In either case it is light out of place. The latter type is frequently the more important of the two, since it is likely to be overlooked. It comes either from the machine that is doing the work or from the piece being worked upon, such as a part being machined. Frequently, systems of lighting to which much thought has been given have not worked because glare from reflection was forgotten.

It is particularly important that it be eliminated from any system of local illumination that may be devised.

The factors which determine the presence of glare and the degree to which it is found are as follows:

1. The amount of contrast between the source of light and the surroundings. If this is excessive, glare results.
2. The intrinsic brilliancy of the source. This should not be above $2\frac{1}{2}$ candles per square inch or there will be glare.
3. The angle between the source of light, the work, and the eye. This angle may be so small as to bring the source of light within the line of vision. The minimum angle is about 30 degrees. It is therefore necessary that the source of light should be so located that it cannot be seen except at a considerable distance, that no source of light be visible when the head is inclined toward the working surface, and that all areas under observation should be, in general, of about the same degree of brightness.

It is best to have light proceed from many directions, so that there is no predominating center of radiation. On this account it is desirable to use several units of relatively low intensity, rather than one unit of high intensity.

That lights should be safe and should discharge as few impurities into the air as possible, are two self-evident facts. The difficulty with many gas installations is that they develop vapors and fumes which materially injure the condition of air in the room. This is overcome in a measure if there is a good ventilating system installed. Still, good lighting should be made possible without paying any special attention to other features of factory operation, such as ventilation.

The electric filament light is now standard for industrial illumination. Some installations of gas lighting are still being made, particularly near natural gas fields where gas is cheap; but there is no question that electric lighting, with its ease of control, is the best available. Electric arc and vapor lights are used to some extent, but not as much as formerly. Mercury vapor lights are excellent when elimination of shadows is of paramount importance, as in silk-throwing. They are used extensively here and in printing establishments. But most of the recent development work of illumination engineers has been in the utilization of filament lamps. With the increase of capacities which has been effected, with the betterment of the technique of light distribution, through the use of better reflectors, and with other similar advances, the filament lamp has gradually replaced other types of electric units. A mass of accumulated information concerning the use of these units is at the disposal of any user at any electric service company.

Methods of arranging artificial lighting sources. In installing lighting systems to fit the requirements that have just been mentioned, there are several methods of arrangement which may be employed. They are each individually suited to particular conditions, but combinations of them are usually desirable. The methods employed are: (1) general lighting, (2) group lighting, and (3) local lighting. The most frequent combination of these is that of general and local lighting.

General illumination is gained through the use of comparatively large units placed near the ceiling, giving an illumination of approximately equal

Courtesy National Lamp Works.

FIG. 23.—General Lighting. Assembling small parts for adding machines—200-Watt Mazda C Lamps, 9½ feet above floor. The sharp shadows suggest the possibility of improvement through the use of bowl-enameled lamps.

intensity throughout the whole workroom. Under many conditions this system is economical and entirely satisfactory. It is especially suited to large, high, open workrooms, and to miscellaneous work where a general distribution of light is more necessary than a local centralization of light in special places. An example of such conditions is found in Fig. 23. General lighting, properly spaced, gives an even diffusion of light under the most adverse conditions, as is illustrated in Fig. 24, which shows an absence of shadows, even though there is a forest of belts in the room. A comparison of this illustration with Fig. 25 clearly indicates that local lighting alone, under these conditions, makes for glare and low average intensity.

Courtesy National Lamp Works.

Fig. 24.—Screw Machine Room—"After." General lighting, 11 feet above floor, 100-Watt lamps, illumination 6 foot-candles.

Courtesy National Lamp Works.

Fig. 25.—Screw Machine Room—"Before." Local lighting at irregular distances and heights. Average illumination 0.2 foot candles.

Group lighting, or, as it is often called, localized general lighting, consists in lighting a particular group of machines, or particular area, by light units which are so placed with reference to the work as to illuminate it from the best direction. This type of lighting is particularly suitable for large rooms with many machines of the same type, performing such operations as spinning, weaving, buffing, etc. The distinguishing difference between general lighting and group lighting is that in the former, the room itself is lighted without reference to the location of the work,

Courtesy National Lamp Works.

FIG. 26.—Cotton Mill Weave Room—"Before." Miscellaneous units, spaced in work aisles 20 to 24 feet apart.

while in the latter, the lights are always placed with reference to the particular location of the work. Group lighting is growing in favor and is being successfully applied to classes of lighting in which formerly only local lighting was successful. Figure 26 illustrates a weave room before group lighting was installed. Not only is the intensity insufficient, but the lights are badly spaced, and the white materials so contrast with the surroundings as to cause glare. Figure 27 shows the same room under group lighting. The lights have been installed so that each one illuminates four

looms. If the looms did not cover the whole floor, the remainder could be illuminated generally.

Local lighting consists of the illumination of a single machine or portion of a machine with light which is specifically directed to the point at which illumination is most needed. Such lighting is used on work benches, lathes, sewing machines, or any class of work where a light may be needed from a nearly horizontal direction, or where a high intensity of illumination is required over a small area. There have been many errors made in the

Courtesy National Lamp Works.

FIG. 27.—Group Illumination. Cotton Mill Weave Room—"After." 200-Watt Mazda C Lamps, bowl-enameled, mounted 12 feet above floor, and spaced approximately 12½ feet × 12 feet. (1 lamp to each four looms.)

name of efficient local lighting. Drop-cords have been largely used as a means of getting local lighting to the point desired. Modern lighting installations have eliminated drop-cords, not only because of their unsightliness but because of the danger from their becoming worn, and have replaced them with fixtures such as that illustrated in Fig. 28.

It is with local illumination that the greatest care must be taken to guard against glare from reflection, as the source of light is so close to the

machine and the material being worked upon. Local lighting can never be used alone, but must be combined with general or group illumination. In the illustration, a 15-watt lamp is used for the local unit, and this gives an illumination intensity of 35 to 40 foot candles at the needle, but this is supplemented by general lighting which gives an illumination of about 8 foot candles in the room. Unless the general illumination be considerable, the relative darkness of the room as a whole, as contrasted with the brilliance of the workplace, will result in extreme eye strain.

Courtesy National Lamp Works.

FIG. 28.—Effective Local Illumination.

Local lighting frequently gives adequate illumination in cases where it can be secured by no other method, for instance, if there is an inside cut being made on a lathe.

The source of light is but raw material to work with in the provision of proper lighting. It is the dome or reflector which turns this raw material into the finished product of adequate and proper light. One type of reflector concerning which much has been said is the "indirect" type. In this type of reflector the light rays are reflected from the ceiling or special

surface placed above the source of light, and no rays come through the bowl of the reflector, which is between the light and the work. Indirect lighting has not proved successful in factory installations. It is too costly, because of the large share of the light that is lost. Furthermore, in any sort of dusty or smoky trade, it is impossible to keep the reflecting surface clean, with the result that the effectiveness of the installation is very rapidly decreased.

There are numerous types of direct and semidirect reflectors, any one of which is good under conditions which favor its use. The glass reflector

Courtesy National Lamp Works.

FIG. 29.—R L M (Reflector and Lamp Manufacturers') Standard Dome.

is not usually good, because too much light goes above the light source and illuminates parts of the room which require but small illumination. The portions of the room under the glass reflector can be properly illuminated if the glass is cut properly. Ordinarily, however, glass reflectors are used only as protection for the light bulb and for appearance. It is with the other types of reflectors that the most scientific experiments have been made. Plain steel reflectors are effective at times and have largely replaced the old-time tin reflector which was the first type of reflector in general use in factory installations.

Enameled steel reflectors are the ones with which the greatest developments have been made. They are rugged, durable, do not catch dust read-

ily, are easily kept clean, reflect diffusely and are highly efficient. The loss by absorption does not usually exceed 25 per cent if the enamel is of the correct color. A grayish or bluish color absorbs much more light than a white or yellowish one. The difference is likely to be as much as 10 per cent, and it is therefore important that the enamel be correctly toned. One very effective modern type of reflector is the standard R L M type illustrated in Fig. 29, the type found in nearly all previous illustrations. This reflector, or its equivalent, is assumed in the computations of mounting heights, spacings, and sizes of lamps which follow.

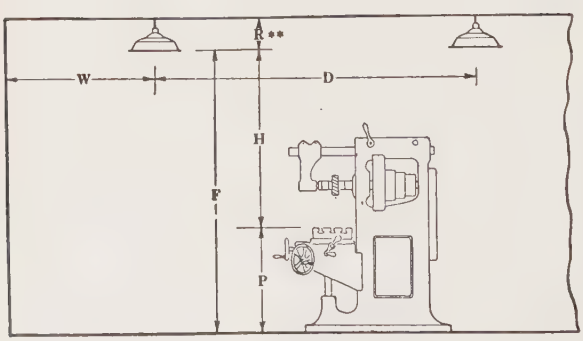
Special reflectors must be used under unusual conditions. Deep bowl reflectors must be used where a deep shielding angle is required to eliminate glare from the lamp filament, for instance where the mounting height is low, less than 8 feet above the floor. For all elevations up to 20 feet it is best to use a bowl-enameled lamp; above that clear lamps may be used. Reflectors of milk glass or with bottoms of this material are used where elimination of all shadows is absolutely essential, as in office or drafting-room work.

Spacing of outlets and selection of lamps. At times the structural features of the room, for instance, the presence of pillars, will influence the spacing of outlets for illumination, and may affect the type of reflector. Ordinarily, however, the reflector will remain standard and the spacing and size of lamps will be determined concurrently. These will be interdependent and will also depend on the illumination needs of the work and the height of the work above the floor.

Proper spacing and the selection of lamps of the proper intensity have been materially aided through the studies of those manufacturing illuminating equipment. The accompanying charts (Figs. 30 and 31), prepared by the National Lamp Works, are examples of these. Figure 30 may be utilized to determine the spacing between outlets. After this has been determined, and the number of outlets is known, Fig. 31 may be utilized to determine the size of lamp required.

The proper distance between outlets is determined from Fig. 30 largely on the basis of the mounting height of the illuminating unit above the floor or above the plane of the work. Utilizing the type of reflector which has been described, the light source is naturally in the center of the area which it illuminates. The intensity which is desired must now be ascertained, based on the type of work to be done. Since the area to be illuminated by each lamp is now known, the size of lamp necessary can be determined from Fig. 31. The curve next above the determined point on this chart should always be selected, unless interior surroundings are unusually good, when, in some cases, the next smaller size of lamp might be used. To illustrate, if reference to Fig. 30 has indicated that the proper spacing be 12 feet, since approximately 144 square feet are to

Mounting Height of Unit		Permissible Distance between Outlets	Permissible Distance between Outlets and Sidewalls	
Above Plane of Work (H)	Above Floor* (F)	(D)	In Usual Locations where Aisles and Storage are Next to Wall (W)	In Offices where Work Benches are Next to Wall (W)
4	$6\frac{1}{2}$	6	3	2
5	$7\frac{1}{2}$	$7\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{1}{2}$
6	$8\frac{1}{2}$	9	$4\frac{1}{2}$	3
7	$9\frac{1}{2}$	$10\frac{1}{2}$	5	$3\frac{1}{2}$
8	$10\frac{1}{2}$	12	6	4
9	$11\frac{1}{2}$	$13\frac{1}{2}$	$6\frac{1}{2}$	$4\frac{1}{2}$
10	$12\frac{1}{2}$	15	$7\frac{1}{2}$	5
11	$13\frac{1}{2}$	$16\frac{1}{2}$	8	$5\frac{1}{2}$
12	$14\frac{1}{2}$	18	9	6
13	$15\frac{1}{2}$	$19\frac{1}{2}$	$9\frac{1}{2}$	$6\frac{1}{2}$
14	$16\frac{1}{2}$	21	$10\frac{1}{2}$	7
15	$17\frac{1}{2}$	$22\frac{1}{2}$	11	$7\frac{1}{2}$
16	$18\frac{1}{2}$	24	12	8
18	$20\frac{1}{2}$	27	$13\frac{1}{2}$	9
20	$22\frac{1}{2}$	30	15	10
22	$24\frac{1}{2}$	33	$16\frac{1}{2}$	11
24	$26\frac{1}{2}$	36	18	12
27	$29\frac{1}{2}$	$40\frac{1}{2}$	20	$13\frac{1}{2}$
30	$32\frac{1}{2}$	45	$22\frac{1}{2}$	15
35	$37\frac{1}{2}$	$52\frac{1}{2}$	26	$17\frac{1}{2}$
40	$42\frac{1}{2}$	60	30	20



*Plane of work (P) assumed to be 2½ feet above the floor. When the plane of work is higher or lower than 2½ feet above floor, neglect column (F) and work from column (H).

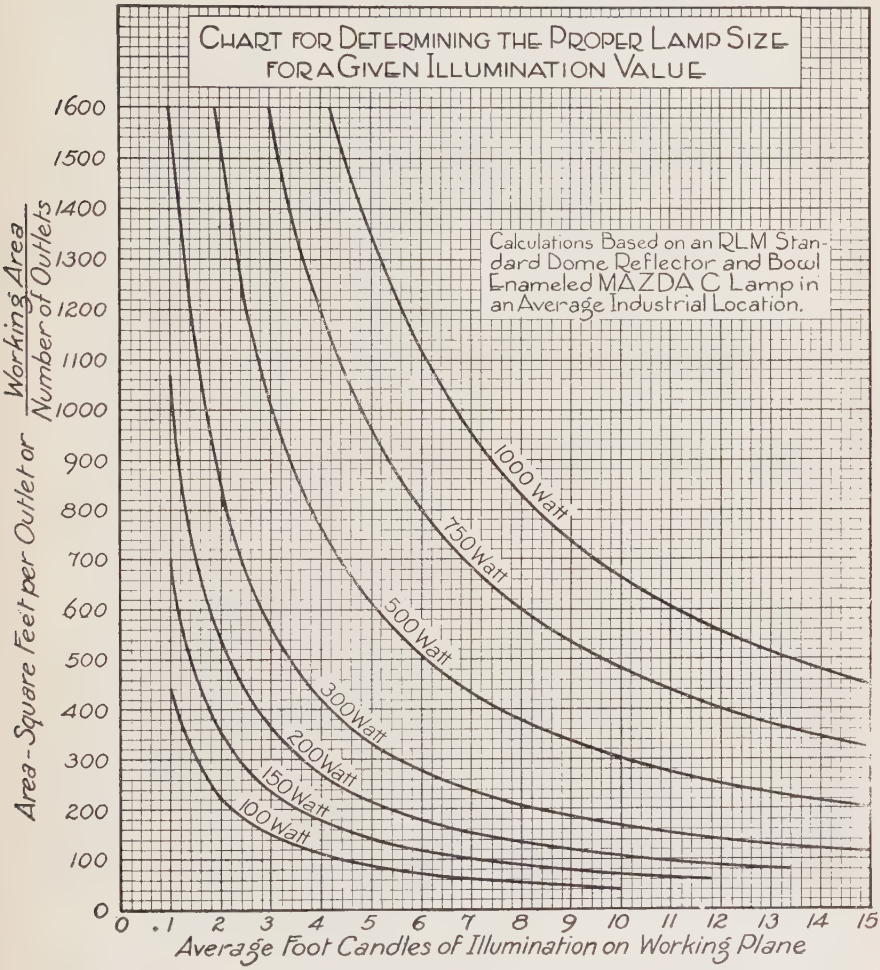
** Minimum allowance for (R) usually 1 foot.

Courtesy National Lamp Works.

FIG. 30.—Chart for Determining Proper Spacing between Outlets and Proper Mounting Height above Work or Floor.

be illuminated by each lamp, if 7 foot candles of intensity are needed, reference to Fig. 31 will indicate that 200-watt lamps should be used.

Maintenance of lighting installations. The last consideration in a lighting installation, and the one of the most continuing importance, is



Courtesy National Lamp Works

Fig. 31.

the proper maintenance of the system. It makes no difference how effective the system may be when first installed; if it is not kept up to the standard which was set in the first instance, it will be of no enduring value. Dull tools are not permitted in any well-organized shop. Dull lights, however, are not at all uncommon. The maintenance of the lighting

system involves a systematic plan for keeping the lights and reflectors in a clean and otherwise suitable state. Dirt, grease, smoke, and other impediments to effective illumination may easily reduce the light distribution 50 per cent or more, and a reduction of from 10 to 20 per cent is not at all uncommon. When lamps deteriorate so that their effectiveness has become reduced, they should be immediately replaced. This involves accurate knowledge of the amount of light at given points at regular intervals. This information may be secured through the use of the foot-candle meter. There is a general tendency to continue lamps in service far past the point where the installation of new lamps would be profitable. The maintenance of the lighting system should be definitely placed in the hands of one member of the organization. This man may or may not be the one who had charge of the lighting installation in the first instance. Either the works engineer, who has to do with general maintenance, or the safety engineer may be the man.

CHAPTER XII

INDUSTRIAL AIR CONDITIONING

That air conditions within a factory are important from the standpoint of production is well known. What the quantitative effect of poor air conditions is on the production of factory workers is not at present so well known. A committee, with Professor Ellsworth Huntington of Yale University as head, is at the present time making a study of the effect of various temperatures and humidities on factory workers in a number of factories throughout the United States. It is hoped that more information will be available at the completion of this study. However, studies already made by Dr. Huntington [1] and others on the effect of the atmosphere on man in different parts of the world, make it certain that there is a direct reduction of output, as well as increased absence due to illness caused by poor air conditions within a factory. It is merely necessary to contrast the feelings of an individual on a hot, muggy August day and on a cool, bright fall morning to understand that energy, and hence work done, is somewhat dependent on atmospheric conditions. Because of ineffective heating and ventilation systems, many a factory worker is kept at an August production level by an August atmosphere in his workroom during the winter.

Effects of poor air conditions. The effects of poor industrial air conditions may be divided into the effect on the employees, the effect on the material, and the effect on the equipment. The effect on the employees, as already suggested, may result in a direct decrease in production on account of a decrease in the worker's effectiveness, or may result indirectly in decreasing production because of illness among employees. Although the amount of direct decrease in production cannot be stated with any degree of assurance, nevertheless it is only necessary to observe factory conditions in certain plants to know that there is considerable decrease in productive effectiveness. For instance, in some paper mills, dye houses, and hat factories where air conditioning has been given little or no attention, water from the steam used in the process condenses during the winter months and drops down on the workers and the work in a way that resembles rain. So great is condensation of moisture in the

[1] "Civilization and Climate," by Ellsworth Huntington. Yale University Press.

sizing room of one hat factory that the workers have uniformly provided themselves with umbrellas under which they perform their duties.

What are poor air conditions? That poor air conditioning causes illness is fairly well demonstrated. One company put up a modern industrial plant without giving much consideration to good ventilation and had $27\frac{1}{2}$ per cent of its employees ill during each of the first two winters. A ventilation system was installed and this percentage was reduced to 7. Such a change is due to a number of the factors in the air condition. Some of those which have been looked upon as most important in the past are, in reality, of no great moment. For instance, the decrease in the percentage of oxygen, which has frequently been regarded as important has, after test, except in the most crowded factory workrooms, proved to be so small as not to be worthy of mention. The increase in CO_2, carbonic acid gas, which is important if large, is ordinarily found to be of no great moment since, except in the most crowded workrooms, the increase is but slight. The increase in volatile organic products, possibly including infectious bacteria, in the air, is of such importance that it has been demonstrated that factory air should be either changed periodically or should be washed if the same air is reutilized. Frequently the addition of gases and fumes due to the processes is sufficiently important to justify some special treatment for the ventilation of those rooms in which these processes are performed.

The most important factors in poor industrial air conditions are improper temperature and improper humidity, or a combination of these two. Approximately 3000 cubic feet of air per person per hour, of the right temperature and humidity, should be provided, and the air can be changed from three to five times an hour to give this amount of air per person without any feeling of draft in the room. The proper temperature of air in a factory workroom depends upon the operation and upon the humidity. If the operation be one involving hard manual labor, it may be that in the winter months a temperature of 55 degrees will be sufficient. The ordinary factory workroom can be held at 65 degrees and be comfortable if the humidity is correct. In the usual type of steamheating system that is likely to be found in a factory, air which is 40 degrees in temperature on the outside is brought in and heated up to 70 degrees. Naturally, this dries the air and makes it absorb moisture from anything, particularly from the bodies of the workers in the room. This gives rise to the feeling of discomfort and irritation which is frequently found in factory workrooms during the winter months. Air at 75 degrees temperature and 20 per cent relative humidity is not as warm as air at 68 degrees temperature and 50 per cent relative humidity, or 65 degrees temperature and 65 per cent relative humidity. Of course, humidity cannot be continually increased. Much of the discomfort of summer temperatures

is due to the high humidity, and 70 per cent humidity is probably the maximum to which any air should be allowed to come. Methods of securing these air conditions will be referred to shortly.

Effect of air conditions on material. Incorrect air conditioning in bakeries, textile mills, cabinet-working plants and other industries, makes difficult the proper working up of material and brings with it high production costs. In bakeries, unless certain conditions of temperature and humidity are maintained, the dough may be coarse or sour, and the rising of the dough is not uniform. A flat loaf is caused by too little humidity. Loaves with large air bubbles in the center are caused by varying humidity and temperature. In textile mills, it is essential that moist air conditions be present. This was the original cause of the textile mills of New England locating near the foggy seacoast. If there is too little humidity in the atmosphere, the yarn becomes very dry in weaving and snaps, thus necessitating frequent stoppage of the loom and knotting of broken threads. If the humidity is too great it affects the texture of the yarn, causing it to swell unevenly and making a poor grade of goods. Cabinet-making plants, where veneering is used, also have less trouble with their raw material when it is worked up under proper temperature and humidity conditions.

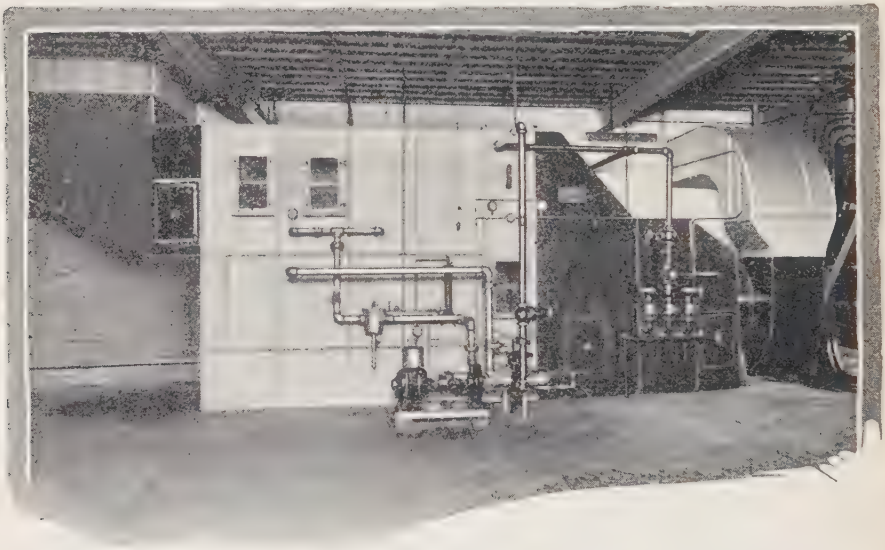
Effect of air conditions on machinery. Air can either be too damp or too dry with respect to the machinery in a plant, particularly in the case of fine machinery, such as that used in hosiery mills. If the air be too damp the machinery rusts and the parts drag. If the air be too dry, static electricity is created, which hampers the operation of the machines. These requirements of material and equipment must be thought of at the same time that the effect of air conditions on the workers is considered.

Heating and ventilating systems. Older heating and ventilating systems provided for the use of radiators for heat along the walls and for the use of windows as a means of ventilation. This always resulted in non-uniform temperatures, the windward side of the building being cold and the windows creating certain temperature problems because of the seepage of air usually occurring around them. The newer factory construction, involving as it does huge areas devoted to window space, has intensified the difficulties of conditioning air by the old methods in factories, since the large majority of the heat from radiators near windows is likely to be expended in keeping outside cold air from forcing its way in.

Modifications made in this method of factory heating and ventilation have involved the placing of humidifying saddles on the radiators. This has been, in the main, an unsatisfactory way of moistening the air in a room. The placing of humidifiers within a room where their presence was absolutely essential, as in weave sheds of textile mills, and the cutting of portholes back of radiators so that some new air would be constantly

coming into the room for replacement purposes, are two more steps which have been taken. In one-story buildings such as foundries, ventilators in the roof worked by the suction power of wind, or double saw-tooth roof construction, have aided in changing the supply of air within the factory workroom and have proved particularly satisfactory where fumes or smoke are present.

Blower-type air conditioning systems. The most satisfactory type of air-conditioning system involves the utilization of a blower or fan which draws a fresh air supply into the building, and propels it through the building by means of ducts, the outlets of which are properly spaced and so



Courtesy American Blower Co.

FIG. 32.—Equipment for Ventilation, Humidifying and Air-conditioning. The Schulze Baking Co., Chicago, Ill.

constructed as to prevent the seepage of cold air through window surfaces. Such apparatus ordinarily provides for drawing the air supply through plates for cleansing purposes, and through water spray for humidifying purposes, and can be so controlled that any degree of temperature or humidity desired can be secured. An illustration of such apparatus, used in the Schulze Baking Company, Chicago, Ill., will be found in Fig. 32. The method of distributing this air will vary with the type of building construction, as indicated by the illustration of the south yard machine shop heating system in the New York Shipbuilding Corporation, Fig. 33; and the illustration showing distributing ducts in the columns of the plant of the Crown Cork and Seal Company, Fig. 34.

In spacious shops, such as that of the New York Shipbuilding Corporation, it is perfectly satisfactory to reutilize old air which has been heated, thereby saving considerable on the coal bill.

The effect of utilizing this type of air conditioning and distributing system is that air heated to the proper degree of temperature and in the proper degree of humidity is uniformly distributed to all portions of the factory building. The air changes constantly at low velocity and thereby removes the film of air around the human body which always exists with poor ventilation. The system provides for an inside pressure in order to

Courtesy American Blower Co.

FIG. 33.—South Yard Machine Shop Heating System, New York Shipbuilding Corporation, Camden, N. J.

propel the air throughout the building. Thus all leakage is outward, preventing cold air coming through the windows with consequent increase in fuel bills. All dust and other foreign matter are eliminated from the air by the washing process which it goes through and, as a final advantage, the space near the windows where radiators would ordinarily be found, and which is most valuable for productive work, because of lighting conditions, can be so utilized.

Many plants which have installed air conditioning systems of this type found it very difficult to prevail upon employees to keep the windows closed. In fact, some plants have had to go so far as to nail their windows

shut, and even then they frequently found in the summer time that employees had removed these nails, although theoretically the air conditions within the building were much more satisfactory than those on the outside. Experience has seemed to indicate that it is probably best, where employee opposition against the keeping of the windows shut is faced, and where an educational campaign fails, to make no attempt to combat the psychology of the employee who desires to open the windows. It may be that this desire on the part of the employees to open the windows is due to the desire to have a change in atmospheric conditions. It is probable, based on researches made to date, that an error has been made in supplying strictly uniform air conditions at all times. Human beings seem to thrive best in those sections of the world where temperature changes are constant and rapid. Whether this means that air and humidity conditions within the plant should be constantly changing cannot be determined until further investigations have been completed.

Courtesy American Blower Co.

FIG. 34.—Distributing Ducts for Heating System in Columns on Machine Shop Floor, Crown Cork & Seal Co , Baltimore, Md.

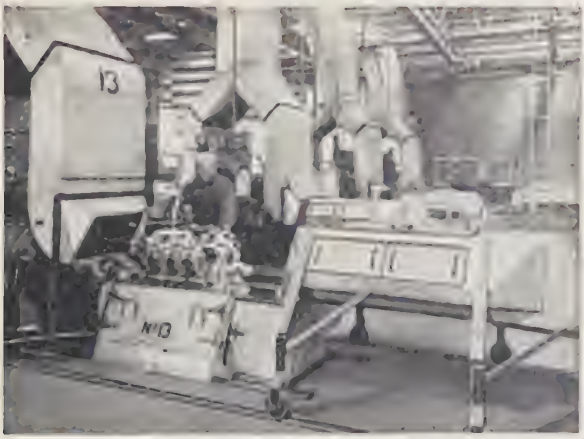
Special air conditioning problems. Special air conditioning problems in factories must be handled in special ways. The separate humidifier, which is located in the weave rooms of many textile mills, is still solving the problems of a large number of such plants satisfactorily. However, air conditioning systems such as those just described can be of benefit to such textile plants, particularly in the summer time, because, through them, humidity can either be added to or subtracted from the amount contained in the atmosphere at any given time. In summer time proper processing demands a subtraction from the amount of humidity in the air rather than an addition to that amount. Condensation in dye houses and other similar places can be eliminated with the air conditioning system just described, by directing outlet vents of dry warm air directly to the roof and to the floor. This prevents dripping at the top by absorbing the moisture, and similarly prevents the creation of a fog below. The problem of the bakery is solved by establishing a proof chamber with a tem-

perature of approximately 120 degrees and correct humidity, which is easily controlled. This chamber can be separated from the workrooms where the workers are found.

Courtesy American Blower Co.

FIG. 35.—Cool Air Ducts for Men and Molds in the Glass Plant of Turner Bros., Terre Haute, Ind.

Glass factories and other plants where workers are likely to suffer from intense heat, can have the air conditions bettered by means of a ventilating system which includes cold air ducts, such as those illustrated in Fig. 35 and installed at the Turner Brothers glass plant. Gases, or other waste products which would be likely to contaminate the atmosphere, can be eliminated by means of an exhaust system attached to the



Courtesy American Blower Co.

FIG. 36.—Exhaust System in Motor Testing Department, used for carrying off smoke, gases, etc., Willys-Overland Co., Toledo, Ohio.

same air conditioning apparatus that supplies air for the plant, in the way illustrated by Fig. 36, representing conditions in the motor-testing department of the Willys-Overland Company.

CHAPTER XIII

FACTORY POWER

The management of an industrial establishment is concerned with only two questions relative to factory power: (*a*) That there is adequate power at the machines to do the full amount of work scheduled for the factory. (*b*) That this power is secured in the most economical manner. The details of the methods determining the amount of power required, and of how it is to be obtained are problems to be solved by the engineer, rather than by the management. In fact, so technical is the solution of these problems, that it will be expensive economy to dispense with engineering advice on this subject. The subject of factory power is so large that it is impossible to give it adequate technical treatment in this book, even though it properly had a place in it. It is only necessary for our purpose to so outline the general principles governing the subject as to enable the manager intelligently to consider the engineer's report.

Adequate power. The term "adequate power" will have different meanings in different industries due to the different character of demands on the power system. In a textile mill the power required per machine of each type is a relatively constant quantity, and adequate power here means sufficient power to run the maximum number of machines that may be in operation at one time. In a rolling mill, on the other hand, the power demands at each stand of rolls will vary from minute to minute, depending on whether the rolls are breaking down ingots or giving the final finishing pass to the rolled section. In machine shops, adequate power means power actually delivered at the cutting points of the tools in sufficient quantity to take all cuts at the highest possible speed consistent with the conditions of the work.

The delivery of adequate power to the cutting tools—or to the point of application of power in any machine—involves adequate strength in all the transmission machinery, including machine gearing, belts and shafting, and minimum losses in bearings, motors, gears, chains, belts, engines, generators and boilers. Many concerns are suffering from lack of adequate power, not because they have insufficient boiler or engine capacity or motors apparently too small for the job, but from lack of attention to the connecting links between the primary source of supply and the point of application of the power.

Some of the causes of apparently inadequate power which have been encountered in industrial plants, and the remedies applied are:

Cause	Remedy
Machine gearing too weak for work.	Heavier gearing.
Belts unable to pull load.	Heavier belts or greater tension in belts.
Excessive line-shaft friction losses.	Roller bearings on shaft. Alignment of shafting.
Machines requiring relatively constant power on same shaft with machines taking heavy drafts of power at irregular intervals.	Regrouping of machines. Individual motors on heavy power consuming machines.
Main motor too small.	Group driving. Individual motors on heavy tools.
Generator too small (Alternating Current)	Raising power-factor of load.
Engine capacity inadequate.	Resetting valves. Repairing of leaky valves and pistons. Installation of condenser.
Insufficient boiler capacity.	Boilers cleaned of soot and scale. Supervision of firing. Mechanical draft. Better operation of stokers. Redesign of furnaces. Change in fuel. Use of exhaust instead of live steam for heating.

Inadequate power does not always mean, in the case of the individual power plant, insufficient generating capacity; or in the case of purchased power, too small motors. The investigation of the sources of loss between boiler or motor and the point of application of power, may postpone to a distant date the purchase of new boilers, engines, generators and motors.

Adequate power is an engineering problem from start to finish. The wisest management will be guided by the advice of engineers in its solution. A few hundred dollars spent for engineering services may easily result in the saving of several thousand dollars of operating cost annually.

Sources of power. Broadly speaking, the industrial plant has two sources of power supply. It may make it in its own power plant, or it may purchase it from a central station. The former is generally referred to as isolated plant power, and the latter as central station power. Whether to use one or the other is largely an economic question, modified to some extent by considerations peculiar to the plant itself. The basic principle to govern the selection is: That source of power is best which will deliver an adequate amount of power at the lowest cost per horsepower-year; local conditions of the plant, and the best form of contract that can be made with the central station must be taken into consideration. Before this principle can be applied, an analysis of the items entering

into the cost of power must be made, and the influence of local conditions on these items considered. This is done in the following paragraphs.

Classes of power plants. Leaving out the plant which is driven directly from a steam engine or hydraulic turbine by belts or ropes, and considering only those in which the prime mover generates electric current which is utilized in motors, etc., we find that current can be generated by (*a*) steam plants, using either engines or steam turbines; (*b*) hydro-electric plants; (*c*) gas-engine plants, using producer, natural, blast-furnace or coke-oven gas; (*d*) internal combustion engine (other than gas) plants employing fuel oil, gasoline or other liquid fuel. For our purpose, a study of the steam plant will be sufficient to illustrate the principles involved.

Items entering into cost of power. The cost of power is made up principally of the following items: Fuel, water, attendance, labor, supplies (waste, oil, etc.), interest on investment, depreciation, maintenance and repairs. The analysis of the cost of power into these items can best be illustrated by an example.

Example. Assume an isolated plant with a maximum capacity of 1500 kw., generated by two 750-kw. turbo-generators, steam being supplied at 200 pounds per square inch pressure and 100 degrees superheat, by two 300-horsepower boilers, equipped with underfeed stokers. The plant is located adjacent to a river or other source of water, from which water can be pumped for boiler feeding and condensing. It is also equipped with coal- and ash-handling machinery, to reduce the labor in the boiler house. The power plant furnishes power to a manufacturing establishment that operates 60 hours per week, 310 days in the year. For the purpose of simplifying the analysis, we will assume that the factory continuously uses the entire 1500 kw. output of the power plant.

The records show that coal is bought for $6.00 per ton, and is used as follows: For supplying steam for operation, 30,400 pounds per working day; for stand-by with banked fires, 14 hours per working day, 3500 pounds per day; for stand-by, 52 Sundays per year, 156 tons per year. The total coal used is 5416 tons per year, which at $6.00 per ton amounts to $32,496.

The turbines use 16.4 pounds of steam per kilowatt-hour, which requires that 246,000 pounds of water be pumped into the boilers per working day. The condensers require, on an average throughout the year, 25 pounds of condensing water per pound of steam or 6,150,000 pounds per working day. The cost of this water is the cost of pumping. Approximately 20 horsepower or 15 kw. is required, and at a cost of electric current of 1.4 cents per kilowatt-hour, the cost of pumping for 3100 working hours per year will be $651.

The operating force for the power plant comprises a chief engineer,

an assistant engineer, two firemen, and two laborers. The power-house pay-roll amounts to $13,000 per year.

The total investment in the power plant may be taken as $100,000. For convenience, we may assume a uniform average depreciation rate of 5 per cent on the entire plant.[1] Taxes may be put down at $2500 and insurance at $250.

We may then tabulate the cost of the several items of making power as follows, using round numbers:

Coal	$32,500
Water	650
Attendance and labor	13,000
Interest at 6%	6,000
Depreciation at 5%	5,000
Maintenance and repairs	5,000
Supplies	1,000
Taxes	2,500
Insurance	250
Total	$65,900

Average cost of current per kw.-hr. = $\frac{65{,}900}{3100 \times 1500} = \$0.014$

The foregoing represents the bare cost of power alone, and takes no account of the steam requirements for heating in winter, or steam for processes requiring heat in the plant, of load factors or power factors, all of which modify the calculations, and which are discussed later.

Central station power. The central station, manufacturing electrical energy in large quantities, owing to the refinements in apparatus which it uses, and which are not usually feasible for the small isolated plant, can deliver current at its switchboard at a much lower cost than many isolated plants. Even adding to the cost of current, as calculated in the preceding paragraph, the cost of distribution, it can usually deliver it at the terminals of the customer's meter in a moderate-sized plant at a lower cost than the customer can make it for himself. This statement applies in many cases where the power user has also to install a separate steam plant for heat in winter, and for steam used in processes. Unless an isolated plant is of such size that it will pay to install apparatus that will approach in economy of operation that of the central station, or unless the steam required for process and heating is of such volume as to utilize all of the exhaust from the prime mover, central station power will generally be found to be the cheaper. As a rough rule, if central station power is available it will seldom pay to generate power on the

[1] The depreciation to be charged against the various items of the plant, as boilers, turbines, generators, buildings, coal-handling equipment, etc., vary widely, and in actual practice the items should be separated and the proper rate applied. For the purpose of illustrating the principles involved, however, a uniform rate may be used.

premises in amounts of less than 500 horsepower, unless there is a use for all of the exhaust steam.

Before considering whether or not central station power is advisable in a particular case, it is well to have an understanding of the method by which rates are fixed for central station current. The load on a power station varies from hour to hour, and the maximum load is much in excess of the average load. Nevertheless, the station equipment must be of sufficient capacity, and enough boilers must be kept under steam to enable it to respond, almost instantly, to any demand that may by made upon it. The cost of the surplus equipment, and of this readiness for service must obviously be carried by the customer, and is reflected in the rates he is charged for current. It is clear, therefore, that the closer the average demand can be brought to the maximum capacity of the station, the smaller will be the cost of carrying the surplus equipment, and the charges for current can be correspondingly lowered. The relation between the current actually produced and the maximum capacity of the station is known as the load-factor. The load-factor of a given industrial plant is the ratio of the horsepower actually used to the total horsepower in motors and lights connected to the electric system. A plant with a high load-factor is a more desirable customer for the central station than one with a low load-factor, since the average load more nearly approaches the maximum load, and less surplus equipment has to be maintained.

The cost of supplying consumers with power is made up of several other items in addition to the actual cost of the current itself. Theoretically, each customer should bear his proportion of the cost of the distribution system from the central station switchboard to his own meter terminals. Whether or not any current is used in a given month, the distribution system is there, and the charges on it must be met. Then, too, certain electrical losses occur in the distribution system and transformers, even though no current is used. These losses are a fair charge on the customer. In addition, there is the cost of keeping in service the surplus equipment to meet the peak-load power demands.

The method of charging these costs to the consumer varies with different companies and in different parts of the country. Some companies have a service charge to cover the cost of the distribution system, which is a flat rate irrespective of the amount of current used, with an additional charge for the actual amount of electrical energy consumed. In addition, there may be a stand-by charge to cover the cost of surplus equipment kept available for the customer's use. This is on a sliding scale and decreases as the quantity of current used increases. Then, finally, there is a charge for the actual amount of current used, which charge is on a sliding scale, decreasing as the use of current increases.

While the form of contract and schedule of rates vary with different

companies, that of the Philadelphia Electric Company (Fig. 37) may be taken as typical. It is based on the maximum average demand for power over a given period of time, and on the agreement of the customer to use a certain minimum amount of current in a month.

This maximum demand is the measure of the equipment that the central station must install to be able to supply all the customer's needs. The minimum charge is based on an amount of current which will meet the cost of holding the surplus equipment in reserve, in addition to furnish-

FIG. 37

EXCERPTS FROM TARIFF OF RATES—PHILADELPHIA ELECTRIC CO.

The *Installed Load* consists of all the current-consuming devices located on the premises of the Customer, which are connected to the Company's service, or which can be connected.

The Measured Maximum demand is the greatest load used during the month or billing period as measured by an instrument giving the average of demands over a thirty-minute time interval, provided that in the case of hoists, elevators, welding machines, electric furnaces or other installations where the use of electricity is intermittent or subject to violent fluctuation, the Company will base the Customer's maximum demand upon approximately a five-minute, instead of a thirty-minute interval and reserves the right to require the Customer to provide at his own expense suitable equipment to reasonably limit such intermittence or fluctuation.

Rate "C" Retail Power Service

$7\frac{1}{2}$¢ per kilowatt hour for electricity used equivalent to or less than the first seventy-five hours use per month of the *assessed or measured maximum demand* in the month.

$5\frac{1}{2}$¢ for the next 75 hours.

$3\frac{1}{2}$¢ for all over 150 hours.[1]

The assessed maximum demand shall be equal to 85 per cent of the first 10 kilowatts of installed load plus 55 per cent of all additional kilowatts.

Rate "D" Wholesale Light and Power Service

Stand-by charge: $2.75 per month per kilowatt for the first 50 kilowatts of the maximum demand in the month; $2.50 per month per kilowatt for the excess of the maximum demand over 50 kilowatts.

Current charge: In addition to the Stand-by charge, for all current used for power purposes:

Five cents per kilowatt hours for the first 1,000 kilowatt hours consumption per month.

Three cents for the next 3000 kilowatt hours.

One cent for all over 4000 kilowatt hours.[2]

Rate "E"—High Load Factor Power Service

Available for any customer using the Company's standard high-tension service; and guaranteeing to the Company a minimum use of the demand 6120 hours per annum, equivalent to 20 hours per day, 306 days annually.

Stand-by charge: $15 per annum per kilowatt of maximum demand proportioned monthly.

Current charge: Eight-tenths of a cent per kilowatt hour for first 6,570,000 kilowatt-hours per annum, etc.[3]

[1] (Note how this increases the rate if maximum demand is not approximately equal to average demand.)

[2] (Note the large share of the power bill that the stand by charge, based on maximum demand, comprises.)

[3] (Note decrease in both stand-by and current charges for customers whose demand is steady. Note that this rate is available to all customers who will utilize power a given number of hours, rather than a given amount of power.)

ing the actual current required. When this charge has been met, any additional current can be furnished at a lower cost, and therefore the rates may be lower for increments of energy above the minimum. Hence the sliding scale of charges for increased current consumption.

The justice of such a method of charging will be seen from a simple example. If at certain times of day a customer requires 1000 kw. of energy, and during the balance of the day only 600 kw., the central station must provide equipment sufficient to produce 1000 kw., even though it be used for only a short period. In addition, the wiring, transformers, switches, etc., must be proportioned for 1000 kw. If now, the load be increased to 1000 kw. for the entire day, the cost of the equipment will be distributed over a larger number of units of electricity, and the cost per unit can be correspondingly lower. Hence, a plant with a high load-factor is entitled to and does receive a lower rate than one with a low load-factor. Likewise, a high power-factor will decrease the cost of generating electricity, and plants with low power-factors are penalized by higher rates. The significance of power-factor is explained later.

Central station vs. isolated plant. We are now in position to make a comparison of the relative cost of power as bought from the central station or made in the factory power plant. We have in a preceding paragraph ascertained the cost of making power in an isolated plant under certain given conditions. Assume that this same plant were to buy central station power under rate-schedule D in Fig. 37.

The cost for one year would be calculated as follows:

Stand-by charge per month

50 kw.@$2.75 =	$ 137.50
1450 kw.@ 2.50 =	3625.00
	$3762.50

Current charge per maximum month of 26 working days@15,000 kw.-hr. per day

1,000 kw.@0.05 =	50.00
3,000 kw.@0.03 =	90.00
386,000 kw.@0.01 =	3860.00
	4000.00

Total cost per month $7762.50 = $93,150.00 per year.

The comparatively low cost of the isolated plant power, $65,900, is due partly to the high load factor and partly to the assumption of extremely high operating efficiency. In addition to power, most factories in the United States require heating for from four to six months per year, and this heat must be provided by either exhaust or live steam. With central station power a separate heating plant would be required.

Let us assume the plant in question to be of such a size that a survey by a heating and ventilating engineer showed that 16,200 pounds of

steam would be required per hour to maintain a temperature of 60 degrees in zero weather, and that the heating plant would have to be operated at full capacity for two hours before starting time in the morning to bring the factory up to this temperature, the fires being banked the remainder of the time and on Sundays. These conditions would require 450 boiler horsepower to be available. A 300-horsepower boiler operated at 150 per cent of rating would be installed, and would burn about 70 tons of coal per week. If we assume the weather conditions to be such that for 10 weeks this coal consumption is necessary, and for the balance of the heating period, say 12 weeks, the average coal consumption would be one-half of this amount, we have the cost of coal as follows:

10 weeks, 720 tons@$6.00 = $4320
12 weeks, 420 tons@ 6.00 = 2520

Total cost of coal $6840

The labor cost of operating the heating plant may be taken as $3000 for the season of 22 weeks. Such a plant might easily represent an investment of $40,000, including boiler, buildings, coal-handling and auxiliary equipment, and interest, taxes, maintenance, depreciation, etc., would amount to $6000 per year. The total cost for heat then would be

Coal	$ 6,840
Labor	3,000
Interest, taxes, etc	6,000
Total	$15,840

In the case of isolated plant power, by bleeding from the turbines sufficient steam for heating in ordinary weather, and supplementing it with live steam in extreme weather, the separate heating plant would be avoided and but little additional coal would be required. The cost of power and heat by the two methods then would be

Isolated Plant		Central Station	
Power cost	$65,900	Power cost	$ 93,150
Additional coal for heating (say)	2,000	Heat cost	15,840
Total cost	$67,900	Total cost	$108,990

If the two costs were more nearly equal, the choice of system might turn on other questions. Some of the factors to be considered would be: Reliability of service; reserve for breakdown service; fuel storage facilities; adequacy of fuel service, from transportation standpoint; need of exhaust steam for purposes other than heating; character of load; and in the case of an existing plant, whether it would pay to scrap the power equipment for what it would bring. A factor that would weigh heavily

on this latter question would be the value of the property released from power-plant service for extension of manufacturing. These points are discussed briefly below.

It should be emphasized here that the question of adopting or changing over to central station power is a serious one, and not one to be decided lightly by non-technical executives or solely on the advice of the electric company's salesman. There are too many factors of a purely engineering nature involved, to make it wise to attempt a decision without disinterested expert engineering advice. It should also be borne in mind that the foregoing discussion is far from complete, that the figures are only approximations and are not to be applied to any particular case. It is simply an outline of the method of arriving at a decision.

Power-factor. Power-factor is a term applied to the ratio of the energy apparently developed by an electric generator to the power actually developed. With direct currents the power developed can be ascertained by multiplying the reading of the voltmeter by the reading of the ammeter on the switchboard, the product being the power in the circuit in watts. With alternating currents this product does not represent the power, except under certain conditions and with certain classes of load.

An induction motor will cause electrical conditions in the circuit, which will render possible the utilization of only a fraction of the power apparently developed by the generator. On the other hand, certain other types of electrical machinery, will set up other conditions, which while also reducing the percentage of developed power that can be utilized, are opposite in their electrical effects to those of the induction motor. Such machines if connected in the same circuit as the motor will tend to neutralize its effect on the electrical system. Still other classes of loads, as lights and synchronous motors under certain conditions, have no effect on the apparent power in the system. Thus, if an alternating current circuit supplied only lights, its power-factor would be unity. If it supplied only induction motors, its power-factor would be less than unity, and might be as low as 0.50. That is, the energy in the circuit available for doing work would be represented by (voltmeter reading$\times$ammeter reading$\times$power-factor). The value of the power-factor could be raised by connecting in the same circuit lights or apparatus of higher power-factor, or apparatus of such character that it would tend to neutralize the electrical conditions set up by the induction motor. The power-factor will be the average power-factor of the several classes of equipment, due consideration being given to the size of the loads of each class. The design of the electrical system and the selection of equipment to give high power-factor is a problem for the electrical engineer.

Low power-factor is undesirable in many respects. In the first place it increases the cost of power. The prime-mover driving the generator is

required to develop power equivalent to volts×amperes÷power-factor to deliver at the motors power represented by volts×amperes. It is evident that a power-factor of 0.70 will require 14 per cent more power at the prime-mover than a power-factor of 0.80 on the same circuit. Furthermore, low power-factor will mean larger generators and poor regulation of the electrical system. So serious is low power-factor, that central stations generally charge more for current supplied to plants whose power-factor is below a certain figure, usually 80 per cent.

The same disadvantages of low power-factor apply to isolated plants as to a central station, except that in the case of an isolated plant they may be more serious. Due to the diversity of the central station load among many customers, low power-factor in one plant may be balanced by high power-factor in another. The isolated plant, however, can overcome low power-factor only by judicious selection of equipment, and sometimes only by an expensive change in equipment. The power-factor may frequently turn the decision for or against the central station.

Reliability of service. In a large city, where central station power is distributed by an underground network, and especially where there are two or more central stations connected to the network, the reliability of service is practically 100 per cent. The statement has been made that in New York City, no installation connected to the New York Edison Company's mains has been without power for a period of over three minutes at a time in over ten years. On the other hand, plants at long distances from central stations, and depending on aerial transmission lines, have been shut down for long periods due to weather conditions putting the transmission system out of business. The relative location of the central station and the industrial plant should be considered in the adoption of central station power.

The reliability of service of isolated plants is largely a question of design, competent operation and maintenance, and fuel supply. With good design, careful operation and reasonable attention to maintenance and repairs, there is no reason why the isolated plant should not be just as reliable as the central station, so far as mechanical considerations are concerned. The reserve for breakdowns enters into the design, and is discussed separately, as is also the fuel supply.

Reserve for breakdowns. With the central station, the reserve for breakdown, except at the short periods of peak load, is practically unlimited. The amount of equipment available is usually such that several units could go out of service without affecting the capacity of the station to meet all demands that might be made upon it. In fact, probably nothing except a boiler explosion, wrecking the entire plant, would put a central station completely out of service, and the boilers used in modern central stations are not susceptible to explosion. Even

should an entire station be shut down, if there are two or more stations on the system as in the large cities, the remaining stations would probably be able to pick up and carry all the load, except at the peaks. This would hardly affect the industrial plant, as industrial loads mainly come in between the peak loads.

In the isolated plant the reserve for breakdown consists in either having spare units in reserve, or in so selecting units that any one can be shut down, and the remaining units, by taking a temporary overload, will be able to provide the necessary power. For instance, instead of having the load divided between two units, it is advisable to have it divided among three, each operating normally at its point of best efficiency, any two of which would be able to carry the load at a somewhat lower efficiency. With either of these arrangements the isolated plant should be as reliable as the central station.

Fuel storage and service. The reserve supply of fuel is an important consideration in all power calculations. A plant so located that it is accessible to its source of fuel, as on a railroad line connecting directly with the coal mines, or on a water course providing all-year transportation from the mines, need carry only a small reserve. If, however, it must depend on trucking its fuel, or is in a district inaccessible to the mines, or on railroads which may be interrupted in winter, the fuel reserve must be large. For instance, plants in the northwest, far removed from the mines, and where snow blockades the railroads for long periods, may have to carry a reserve sufficiently large to supply them throughout the winter. The interest on the investment in the fuel so carried is a proper charge on the cost of power, as is also the interest on the value of the real estate used for storage, together with the taxes, etc., on it.

Central stations usually carry adequate reserves of fuel, and are so located as to receive and handle these reserves in the most economical manner. The cost of the fuel reserve is of course included in the rates charged for power. In choosing between isolated plant or central station power, the question of fuel supply and reserve must not be neglected.

Use of steam for heating and process. Where much heat at steam temperature is required in the processes of the plant, or where the quantity of steam for heating in winter is large, it is usually wise to use exhaust steam for this purpose. If all of the exhaust can be so used, the power is a by-product, that is, it is obtained at no cost, except the interest on the investment in power-generating apparatus, the maintenance, repairs, etc., on it, and the attendance. In such a case, the efficiency of the power-generating apparatus need not be so high as where it is used solely for power purposes, although as a general rule, high-efficiency machines are in all ways more satisfactory than low-efficiency ones. The boiler and fuel-burning appliances are excluded from the low-efficiency classi-

fication, for they should be operated at the highest possible efficiency, irrespective of the use to which the steam is put.

The method of determining whether it will be better to use central station or isolated plant power in cases where large amounts of steam are used for heating, is the same as outlined in the preceding paragraphs for the factory heating system in connection with central station power. That is, the amount of steam required is determined and the cost of making this steam is ascertained. If it costs less to make it and buy central station power, than to generate power on the premises and use exhaust steam, central station power would be the logical choice.

The problem, however, is not as simple as this. Instead of using exhaust steam, the isolated plant might find it more economical to operate its power units in connection with a condenser, and use live steam for heating. Or in a high-efficiency steam turbine plant it might bleed a portion of its steam for heating from the turbines, still operating these condensing, and make up the heating deficiency with live steam. The problem is often a complicated one, and its solution should not be attempted except by engineers.

Combination of central station and isolated plant power. Instead of generating all of its own power or of buying all of it from a central station, the industrial plant may find it of advantage to generate a portion and purchase the balance. In this case it may either buy sufficient power from the central station to meet its average requirements, generating in its own power plant the power for the peaks of the load, or it may reverse the conditions and buy from the central station the power for peak loads and for breakdown service. The former combination will reduce the unit cost of power from the central station, as the average load will then approach more closely the maximum load, enabling the plant to take advantage of the lower rates obtaining with high load-factor. The latter procedure will increase the unit cost of power bought from the central station due to the low load-factor, but the total cost of power may be less.

No definite rule can be laid down as to the best method of obtaining power in any particular plant. Whether to buy all or part of the power required from the central station must be determined on the merits of each case, all the factors being taken into consideration.

Distribution of power within the plant. The source of power having been determined, there remains to be decided the method by which the power shall be distributed in the shop. In general, three methods are in use: *a*, single-motor main drive; *b*, group driving; *c*, individual-motor drive. The three systems are illustrated in Figs. 38, 39 and 40.

Single-motor main drive. The single-motor main drive has little to commend it except low first cost. It is largely a survival of the days

when the entire factory was driven from the flywheel of a steam engine, before the electric motor permitted power to be distributed in any direction and in any quantity desired to any part of the plant. In effect, this drive consists of a motor large enough to carry the maximum load that may occur at any one time, belted to a main line-shaft. This line-shaft drives, through belts or other connections, jack-shafts which in turn drive the machine countershafts. The disadvantages of this system are so many and so great that it should not be considered except under exceptional circumstances.

Group drive. In the group drive, instead of the jack-shafts being driven from a main line-shaft, each is driven by its own motor. Or the line-shaft may be cut into sections, each driving a group of machines,

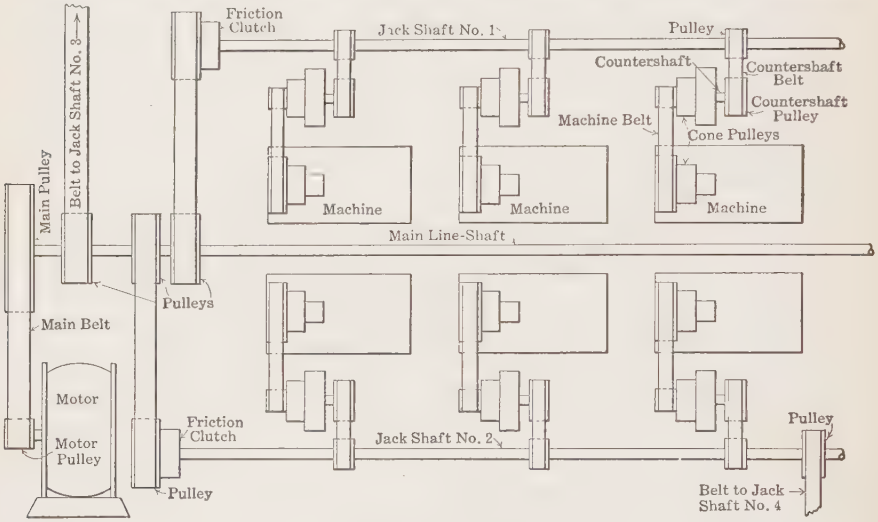


FIG. 38.—Single Motor Main Drive.

each section being driven by its own motor. Or, the various machines of each class may be arranged in groups, and the shafting for each group driven by a single motor. This system, while of greater first cost than the single-motor main drive, is so much more flexible and has so many inherent advantages, that it is the most generally used. With it the shafting friction losses are lower than with the single-motor drive, and any section of the shop can be run at any time without having to drive all the shafting. The machines can be arranged more conveniently for the work, without regard to the position of main line-shafts, and without quarter-turn belts or mule-pulley stands to permit power to be taken off the main line-shaft at right angles to it. The motors can be better proportioned to the average load they will be called on to carry, and the load-factor, and hence the efficiency, of the system will be high.

Individual motor drive. In the individual motor drive, each machine has its own motor, either mounted on it and driving through gears or silent chain, or mounted close by and driving through a belt. This is the most flexible of all systems, and permits machines to be arranged in the manner and position most suitable for the work without any regard for the source of power. It is highest in first cost, and the total horsepower of motors to be installed is greater than in either of the other systems, since each machine must be equipped with a motor large enough to pull the heaviest load that may come on the machine. This will tend to make the load-factor low and also the power-factor if alternating current is used. In the group drive, the motor usually need be only large enough for

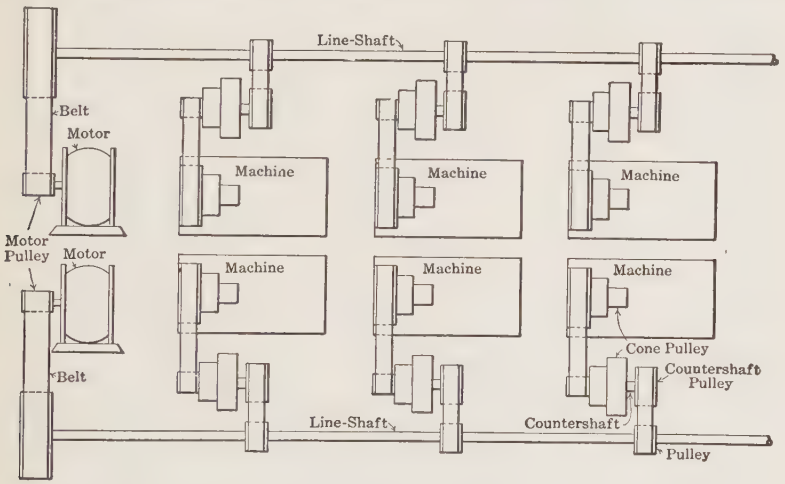


FIG. 36.—Group Drive.

the average load, since it is quite unusual for every machine in a group to be under maximum load at the same time.

Combination group and individual motor drive. Probably the most satisfactory system of driving, particularly in the metal-working industry and in those industries where the demands for power on the several machines is variable, is a combination of the group and individual motor drives. In this system the machines requiring a relatively constant amount of power are driven in groups, while those requiring a large amount of power at irregular intervals are equipped with individual motors. This gives a very flexible system and smooth operation. It is highly undesirable to connect to the same shaft machines using a comparatively small quantity of power, such as screw machines and turret lathes, and machines taking large drafts of power at irregular intervals, such as punch presses and heavy planers. The combination system solves this problem in a very satisfactory manner. The load-factor will

be comparatively high and the power-factor with alternating current moderately so.

The selection of the best system of driving for any particular set of conditions is another engineering problem which it is better to have solved by expert engineers, rather than by non-technical executives or the average master mechanic. Its solution requires knowledge of the operating characteristics of both machines and motors, and also of their effect on the power plant, that is not usually possessed by these men.

Maintenance. Of more importance, perhaps, than wise initial selection of equipment for power generation and distribution, is the establishment of a routine that will insure all of the power-generating, power-transmitting and power-using equipment being kept up to its original

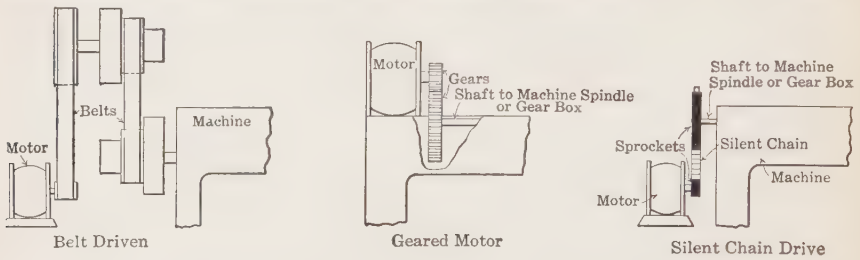


Fig. 40.—Typical Arrangements of Individual Motor Drive.

condition and efficiency. Boilers become scaled and dirty, and their settings develop air-leaks, all of which increase the coal consumption. Engine valves require adjustment from time to time and bearings need taking up. Air-leaks may develop around turbine glands and bearings may become worn to such an extent that the turbine will be damaged. Motors may become dirty, and commutators and brushes wear out. Line-shafts, jack-shafts and countershafts must be kept in alignment, and constantly lubricated, and bearings must be looked after from time to time. Belts stretch and become loose, and must be inspected and kept up to the proper tension. Gearing will wear, and requires lubrication. Neglect of any or all of these things will cause the power bill to run up. Constant vigilance, and a regular system that will fix the intervals at which each item of equipment is examined and adjusted are an absolute necessity in any factory that intends to keep its power equipment at the point of highest efficiency.

Such a routine will pay for itself many times over. It will avoid breakdowns, for it will detect the causes of breakdown before they become dangerous, and will remedy conditions before they cause a smash. Preventive repairs are always less expensive than breakdown repairs, because they can be made at nights and noon hours without shutting down productive machinery in working hours.

PART IV

STANDARDIZATION (A Primary Management Step)

CHAPTER XIV

STANDARDIZATION OF PRODUCT

From a purely production standpoint, all organizations should prefer to produce only one of each type of product in their line. Such a program, although Utopian from the standpoint of the factory manager, is impossible in all but a favored few plants. Demands of the trade and of individual customers make imperative the diversification of product that is necessary to meet various consumers' needs, desires, and purchasing capacities. In some industries, such as those in which taste and style are important factors in purchase, an attempt to produce but one product of each type would mean industrial suicide. However, through many years of practice in meeting the desires and needs of the customer, many organizations seem to have forgotten the reasons behind the manufacturing preference that they should have had for fewer products. They have proceeded so unnecessarily far in diversifying their lines, that it has taken a distinct movement towards simplification, carefully fostered, to bring into prominence the economic and profit-making reasons for standardization, or elimination of excessive diversity of product. The benefits derived from elimination of excess variety are great. To understand them it is necessary to know the causes of development of excess variety, as well as the results, and the ways in which these may be counteracted to the benefit, rather than the detriment of the business.

Causes of unnecessary diversity of product. Unnecessary diversity of product has resulted from two main causes. The first of these is the demand of the consumer for product that is individually different, either to meet peculiar service needs, or because of the style and taste factors. The second, and wholly remediable cause, is that sales methods have been frequently based largely on supplying diversity. Although it will be shortly seen that much can be done towards the education of the cus-

tomer in convincing him that his service needs fall under certain well-defined headings which may be supplied by standard products, and although taste and style demands for diversity may be modified, the most fruitful immediate attack can usually be made by revising sales methods so that they will eliminate, rather than cause diversity.

Sales divisions, selling agents, and salesmen themselves have all felt that one of their strongest selling arguments was that a particular product was a "novelty," or that it was different from anything they or their competitors had before presented to the trade. In addition, they have frequently urged the retailers to stock a huge variety of the product they sell, on the basis of appealing to the consumer's individuality complex. This has been frequently unnecessary and costly to the retailer, as it has meant to him carrying charges and damaged-stock charges which have been many times what they should have been. This may be well illustrated from an industry of which more will be said shortly. Stationers, druggists, and other retailers of writing paper have for years been sold a great diversity of stationery with the thought that they will be better able to sell their customers on that basis. Although a share of the consumer demand is based on taste and individuality, nevertheless a large share of consumers, particularly men, are desirous of being able to obtain continuously the particular style of paper which they last purchased and which they used with satisfaction. To these consumers diversity has frequently meant annoyance, particularly in some such instance as having envelopes remaining which they have been unable to match in a new purchase of paper. Thus the diverse line, sold to the retailer on the basis of greater profit to him, has often meant lost sales, slower turnover of stock, and loss through injury to these fragile goods while lying on his shelves.

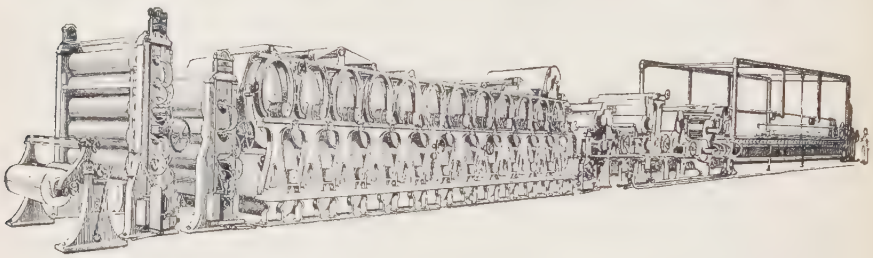
There is a class of sales in this same industry which is based wholly on individuality and diversity. Some high-grade stationers have built up their business on the basis of selling their consumer stationery which is different and which is "special" in every particular. Although some immediate loss of orders would doubtless ensue from an immediate change of policy on the part of these retailers, the manufacturing problems involved, and the costs to the retailer himself, are so great that such a selling policy must necessarily undergo a change. Special orders as small as twenty-four sheets of paper, with envelopes to match, are frequent, and one paper company has received as many as 5000 such orders in a single day during the holiday season. When it is known that most of these orders are ordinarily of the "rush" character, it can readily be seen that any steps toward their elimination would be profitable to everyone with the possible exception of the consumer, to whom, in this case, price is not usually an important factor.

By far the greatest cause of diversity of product has been the practice of selling on the basis of diversity in order to meet competition with a product that could not be easily compared, or with one on which quality or price could be readily shaded. This is the greatest factor in increasing the lines of product manufactured. The development of this policy in the writing-paper industry can well be illustrated from the statements[1] of Mr. George A. Galliver, president of the American Writing Paper Company, which is not the company mentioned in the last illustration. He says, " A jobber learned that a competitor had sold a printer a lot of paper of a certain grade. He then went after this business. He had three arguments to bring to bear in favor of his paper—improvement in quality, less price, or greater suitability. If he made what he looked upon as a big sale, he wanted it to be permanent and bring its own reorders. If he could lead the customer to believe that his paper would be inimitable and unique he might be protected from competition for at least a short time. The best way to stamp it as unique would be to have it made with a special brand in the watermark. Perhaps this brand that he was selling was at the time of the sale purely an imaginary one created in his own mind to induce the sale. Having tentatively made the sale, the jobber would then see the factory salesman and dicker with him for the manufacture of a grade of paper very similar to the other jobber's brand which he was to beat out, and with the price shaded a cent or two—enough so that he could undersell his jobbing competitor without losing money, and still not too much but what he could convince his prospect that the new brand was just as good. Naturally the factory salesman was also eager for business, and he accepted the order with the shading of price. Then he went back to the factory and compelled the mill men to make the paper, arguing that they could meet the almost insignificant falling off in price by making an equally insignificant reduction in the proportion of the best ingredients in the paper. This process once done would not be worth speaking of, but repeated every week and every day, it became a great vice."

Results of diversity of product on production. The effect of selling policies such as just described on the operation of the factory is such that the production costs mount rapidly and it is impossible to institute economies in operation which are simple with less-diversified lines. The American Writing Paper Company, studying the losses involved in that type of selling methods, reduced their line from 2000 separate varieties of paper to approximately 200. Some of the production reasons for this change well illustrate the importance, from a manufacturing standpoint, of the standardization of product. The key machine in the paper-making industry, the paper-making or Fourdrinier machine, a huge machine from

[1] "System," September, 1921. (A. W. Shaw Co.)

50 to 200 feet long (Fig. 41), must be stopped and started every time a new grade of paper is run through it. Not only must many time-consuming adjustments be made on the machine, but there is a huge loss of material from wastage of paper as the machine is being finally adjusted. Frequently the down-time cost on the machine plus this wastage will be sufficient to cause an addition to the cost of production of from 10 to 15 per cent alone, when the runs of paper are short. In addition to these losses there will be the losses incident to idleness of equipment which performs subsequent operations on the paper, and operations which vary on the type of paper being manufactured. Such equipment includes paper-cutting machines, supercalendering machines, etc. The operations performed by these machines do not have to be done on all types of product, but with a highly diversified line it is impossible to plan ahead accurately enough to permit close computing of the exact number of machines of each type necessary to permit the proper balancing of operations. It is



Courtesy Dill & Collins Co.

FIG. 41.—Fourdrinier Machine.

necessary to provide enough equipment to take care of unusual demands, and this means much idle equipment a large share of the time. This idle equipment cost is another factor in the increased cost of production with diversified product.

Benefits of product standardization. The benefits resulting from product standardization are many more than those represented by direct lessening of production cost. In addition to this there may be mentioned these: decrease in capital invested, lower labor cost, advance in the technique of production, improvement in equipment utilization and control, and possibility of speedy and reliable delivery. Together these insure consumer satisfaction because of prompt service at low prices, together with greater profits on the same investment for the manufacturer.

A decrease in the capital investment is brought about through the utilization of less machinery and fewer tools, patterns, and other auxiliaries, as well as through the reduction in the inventories of raw material, parts, or partly worked material and finished stock. Lower labor costs come

with familiarity of the workers with their more frequently repeated tasks, as well as from the steadiness of employment that follows the well-defined production programmes that can be mapped out when the product is standardized. Unsteady employment usually means not only a poorer grade of workers, but even higher wage rates than when the employee feels the certainty of steady work. Technique of production and consequent cost-reduction follow product standardization promptly. The knowledge of the force becomes specialized along narrower lines, and thus there is a tendency toward constant improvement of process, and development and utilization of specially suited machinery and equipment. Standardization of the product will also usually imply development of product with less wastage of material. Thus new styles of standardized metal beds which have been developed utilize on the average one-third less metal than the old styles. Not only can equipment specially suited to the product be procured, but all equipment can be more easily assigned to the production of those numbers in the product to which it is best suited. Two machines of exactly the same type often show peculiar and unexplainable suitability for the production of different numbers of a similar product. With a reduction in the number of products made, it is possible to so control machine utilization as to take advantage of such conditions. Speedy and reliable delivery is possible even with reduced inventories because consumer demand can be more accurately gauged and production programs and finished stock adjusted to meet forecasts. For all these reasons, the thoughtful general manager is apt to be enthusiastic over the development of a program of standardization of product wherever it will not so reduce sales as to vitiate the production economies which it produces.

The final success of such a programme rests on the co-operation of the sales division or selling agent. Sales methods must frequently be changed, and, if not, the influence of the salesmen must be cast on the side of pushing sales of standard products rather than continually suggesting diversity. Co-operation between the sales and production divisions, through regular committees, or through special conference is the first requirement in developing a workable programme of product standardization. The development of a budget of sales and production, as explained in later chapters, is probably the best insurance of successful operation. If this is not practicable, then each item of the line should be carefully gone over in the conference between the two departments, and the requirements of each carefully understood by the other before items of product are either added or dropped.

Programmes of product standardization. There are several programmes tending toward standardization, now in use in various industries, that deserve consideration. These include the revision of sales methods, the

development of a succession of designs where novelty is an important factor, and the development of parts standardization.

The success achieved through a revision of sales methods in a whole industry is best known through the action taken in that direction by the automobile industry. Prior to the success of Henry Ford's experiment in standardized car production, most of the selling talk in the industry had been on the basis of individuality in body design or chassis size, to meet particular individual requirements. Complete revision of models at frequent intervals was not only due to the youth of the industry but to the selling of the product on the basis of diversity or " something new." The effective example of the Ford car, the brass radiator band of which for years made standardization a home word rather than a factory word, was the most influential factor in changing the sales talk throughout the industry. The selling phrases became " carefully drawn specifications," " no radical change in the last five years," " manufacturing economies due to large production," and other similar and well-known selling phrases of the industry of the present. The automobile factory which constantly changed its models frequently succeeded in the general boom of the industry up to 1920. That was the day of reckoning, and a frequent cause of failure in that year was the huge stock of parts, ostensibly repair parts, but in reality left-over parts from past manufacturing programmes which some of the plants had been including in their balance-sheet statements as assets. In the case of one concern, the bankers who took over the business at the time of failure estimated that the inventory on hand was $29,000,000 too large, and this huge inventory was largely parts of old models.

In changing over sales methods to effect standardization, the change is from arguments based on diversity and price-shading to arguments based on, first, better goods at the same price, or the same goods at better prices, due to manufacturing economies, second, service to the customer, and, third, if the product be sold through dealers, quicker turnover and hence, lower investment, damage, and obsolescence charges. Such vital changes in selling methods at times necessitate changes in whole mechanisms of distribution. As an example of this, Mr. Galliver's experience will again be quoted: [1] " Formerly we had a big line of kinds and grades to sell, but we scattered in the selling. One printer who was sold very early on our standardization policy declared that he would thereafter buy our product. But he found it not at all advisable at that time to carry out his resolution, for he would have had to buy of thirty-one jobbers, among whom the agencies for our various brands were scattered. It happened that of these thirty-one jobbers he was in the habit of dealing with only five. Now this demanded correction and we proceeded to correct it. We

[1] "System," September, 1921. (A. W. Shaw Co.)

ceased dealing with thirty or forty jobbers in each district. Instead we selected the leading merchant in each district as the "service house" for his district. He handles and stocks our complete line of all varieties and grades. Most of these merchants had made their prosperity in sales of their own brands, some of which had been made by us, some by others. Yet they were willing to give up many of their brands in favor of our mill brands, because they believed in the business value of standardization and simplification. Simplified lines have brought to the merchant the advantage of volume sales and his sales are easier. The sales of each standard grade build themselves up by the momentum of use. And each time a salesman makes a sale, the salesman sells the idea of the whole series of grades as a complete and integral service line. The work of our sales department has become much simpler. Its principal activity is now in rendering service, rather than manipulating orders. The service division is rapidly becoming bigger than the remainder of the department. The comparatively few merchants through whom we now distribute are now ordering with closer approximation to their needs, and withal continuously. The turnover with them has materially increased."

There are many businesses in which the style factor is so important that whether or not there shall be profits is determined largely by the stylishness of the product. Unusual profits are made by initiating style or, as it is sometimes known, "beating the market." Such businesses are women's millinery and apparel. In such cases, standardization of product over a period of years cannot be thought of. Despite the importance of novelty, taste, and style, much progress can be made in the standardization of texture of materials, as contrasted with design, and with the inner portions of the articles manufactured. Wherever possible, the addition of certain staple styles to the line does much to bring to the plant the benefits of standardization. In such industries much can be done in insuring the elimination of designs of past seasons at the time that new designs are added, thus keeping the total line to a given number of patterns. This idea of succession of designs is very important in all industries where taste and novelty enter into retail sales. An illustration of this is found in the clock industry. The William L. Gilbert Clock Company of Winsted, Conn., desired to reduce their line of approximately five hundred pieces, which had grown up through the course of years by reason of the trade and the salesmen demanding something new every few months. They analyzed the sales of the various patterns and kept only such patterns as had been sold in quantity. By so doing the number of patterns was cut to approximately seventy-five. There is a continuous check kept on the product, so that when interest in a particular number lags, it is quickly dropped and a new design replaces it. Thus the line is rotated and still standardization is achieved.

Parts standardization is an effective way of simplifying the line if demands of consumers call for diversified lines, particularly in assembly industries. Products falling under this head include shoes, furniture, and stoves. The experience of a large stove manufacturer clearly illustrates this step in standardization. The first items standardized were stove lids and stove centers, the cross pieces that hold the lids in place. There are from four to six of these on every stove, and the old method of making them was to have a different size cover for every stove. All types were abandoned except one, and this was made in 7-, 8-, and 9-inch sizes, thereby eliminating many patterns and much of the stock of castings. Next, the legs of the stoves were standardized. These were made in four classes, light legs and heavy legs, both with and without base strips. These four types were substituted for the great variety that previously existed. The bodies of ranges and cookstoves were next developed so that they could be trimmed with many nickeled parts or not, allowing three grades of stoves to be made from one size of body. Many auxiliaries, such as towel rods, swing shelves, lifters, and handles were standardized for practically all types of stoves.

The movement toward product standardization. Large-scale adoption of programmes leading to standardization of product by industries was first brought about in the United States through the action of the War Industries Board during 1917 and 1918. This board had found that one of the greatest obstacles to organization of the industries of the United States on a war basis was the utilization of time, material, and capital involved in unnecessary diversity of product. Starting with industries directly involved in the manufacture of war materials, it called conferences of leaders in each industry to develop a programme for elimination of excess variety. Upon the basis of these conferences, action was taken. As an illustration of the enormous reductions in variety of product which were at this time brought about under leadership of this board may be mentioned the reduction in the number of colors of men's hats to 9, as compared with approximately 100 distinct colors that several factories were previously producing. Another example is the reduction of rear gearings on farm tractors from 1736 to 16. Action in the case of industries closely allied with war operations was quickly followed by action in numerous other industries with a view to general conservation of plant capacity, materials, and man-power. Thus, after conference, the number of styles of chinaware was reduced to 330, a very considerable reduction from the 1130 patterns which one company had been producing.

The direct results of the action of the War Industries Board were not permanent. When freed from the wartime restrictions, many plants were quick to return to the "liberties" incident to the production of great varieties of product. Many of the reductions which had been made

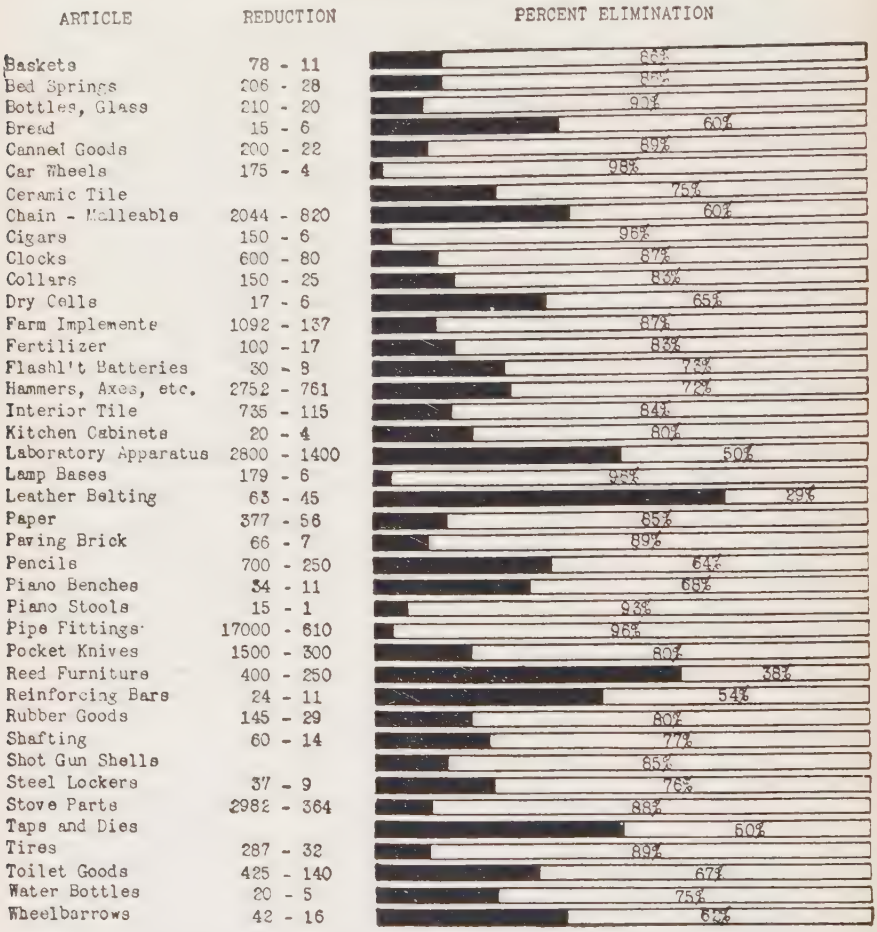
were unnecessarily severe from the peacetime standpoint. However, many manufacturers, having tasted the benefits accruing from standardized production, endeavored to retain them. In the main, the war action has been felt in a continuing way through the action and efforts of the trade associations. Development of standardization programmes represents an ideal field for the action of trade associations, and many of them have been leading their trades in the direction of product standardization during the last few years. However, not all standardization programmes since the war have been developed through trade association action. For instance, Fayette R. Plumb, Inc., of Philadelphia, have reduced their line of tools from 2752 items to 761 items, and feel that they are ahead of most manufacturers in the trade in the extent of reductions. The Walworth Manufacturing Company, of Boston, entering into a programme of simplification, reduced their line from 17,000 to 610 major items, others being added only after general executive consideration. The John Deere Wagon Works went far ahead of the industry by reducing their farm-wagon line from 1200 to 90 and saving as a result $90,000 a year on interest on tied-up capital alone.

Much has been done in trades as a whole through the action of trade associations, with the assistance frequently of the Fabricated Production Department of the United States Chamber of Commerce and the Division of Simplified Practice of the Department of Commerce of the United States. These two agencies have been assisting trade associations in developing product standardization as one of their major activities and have been extremely successful in this connection. The accompanying chart (Fig. 42), issued December 8, 1922, by the Fabricated Production Department of the United States Chamber of Commerce, gives an excellent idea of typical reductions in product diversity in many leading industries at that time.

Trade association action can be helpful in furthering product standardization, not only on the part of manufacturing associations, but on the part of associations of distributors. Distributors will increasingly realize the benefits to themselves of standardization on the part of manufacturers. As this occurs, it can be expected that other similar associations will follow the lead of The National Retail Hardware Association, which in national convention, in June, 1922, passed a resolution favoring a continuing standardization programme. Returns to a questionnaire of this association showed hardware merchants 98 to 99 per cent favorable to simplification in hardware manufacture in general and paints in particular.

This subject is a particularly fertile field for trade association action in industries where the product of one factory becomes the raw material for the next. It is manifestly impossible for a plant manufacturing a primary product, or a component, to attempt standardization of product

if its customers are continually calling on it for diverse and unusual products to form the raw material for their manufacturing processes. Thus, in the manufacture of wood wheels, the plants must be governed by the requirements of the vehicle manufacturers, or in the manufacture of metal plates for pianos, the requirements of the various piano factories


ARTICLE
REDUCTION
PERCENT ELIMINATION
Baskets 78 - 11 86%
Bed Springs 206 - 28 86%
Bottles, Glass 210 - 20 90%
Bread 15 - 6 60%
Canned Goods 200 - 22 89%
Car Wheels 175 - 4 98%
Ceramic Tile 75%
Chain - Malleable 2044 - 820 60%
Cigars 150 - 6 96%
Clocks 600 - 80 87%
Collars 150 - 25 83%
Dry Cells 17 - 6 65%
Farm Implements 1092 - 137 87%
Fertilizer 100 - 17 83%
Flashl't Batteries 30 - 8 73%
Hammers, Axes, etc. 2752 - 761 72%
Interior Tile 735 - 115 84%
Kitchen Cabinets 20 - 4 80%
Laboratory Apparatus 2800 - 1400 50%
Lamp Bases 179 - 6 96%
Leather Belting 63 - 45 29%
Paper 377 - 56 85%
Paving Brick 66 - 7 89%
Pencils 700 - 250 64%
Piano Benches 34 - 11 68%
Piano Stools 15 - 1 93%
Pipe Fittings 17000 - 610 96%
Pocket Knives 1500 - 300 80%
Reed Furniture 400 - 250 38%
Reinforcing Bars 24 - 11 54%
Rubber Goods 145 - 29 80%
Shafting 60 - 14 77%
Shot Gun Shells 85%
Steel Lockers 37 - 9 76%
Stove Parts 2982 - 364 88%
Taps and Dies 60%
Tires 287 - 32 89%
Toilet Goods 425 - 140 67%
Water Bottles 20 - 5 75%
Wheelbarrows 42 - 16 62%

Courtesy U. S. Chamber of Commerce Fabricated Production Department.

FIG. 42.—Chart Indicating Percentage of Elimination of Variety of Product in a Number of Industries.

using the product must govern. Until the requirements of the latter (a wood-working trade) are standardized, the manufacturer of the plate (in a metal-working trade) cannot standardize his product. One manufacturer alone can do little under such conditions. A trade association which interests all its members in this subject, establishes standards,

and works in conjunction with the trade associations of allied trades can do much.

Frequently it is necessary, in order to develop a standardization programme, to effect a meeting of persons of seeming diverse interests, all of whom, however, are in a position to influence the possibility of standardization in the trade. As an example of this may be mentioned the manner in which standardization was brought about in the vitrified paving-brick industry in November, 1921, through a conference at Washington under the auspices of the Department of Commerce. As a result of this conference the 66 existing sizes of paving brick were reduced to 7 standard sizes, with extremely effective results. Among those groups represented at the conference, the presence of all of which was necessary in order to assure practical and lasting standards, were: American Association of State Highway Officials, American Ceramic Society, American Electric Railway Engineering Association, American Society of Civil Engineers, American Society for Municipal Improvements, American Society for Testing Materials, as well as representatives of the paving-brick industry, the Department of Commerce, and the United States Chamber of Commerce.

In Germany there recently has been a combined attempt to set standards for various trades through a central agency, *Normenausschuss der deutschen Industrie*. For instance, they have been endeavoring to develop a series of "preferred numbers," which are recommended for all new standardization where numerical values are required. These numbers may be used for dimensions, speeds, capacities of apparatus, or for any similar use. The attempt is to insure the use of the same number to serve similar purposes, when any nearby number might be equally well employed. Thus if diameters or speeds of pulleys, ranges of power in motors, or any other similar points were under consideration, and 5, 10, or 20 numbers were desired between 10 and 100, the following would be recommended:

5-Series	10-Series	20-Series	5-Series	10-Series	20-Series
10	10	10	..	..	36
..	..	11.2	40	40	40
..	12.5	12.5	..	..	45
..	..	14	..	50	50
16	16	16	..	..	56
..	..	18	64	64	64
..	20	20	..	..	72
..	..	22.5	..	80	80
25	25	25	..	..	90
..	..	28	100	100	100
..	32	32			

Effect of product standardization upon the worker. A possible limiting factor in the extent to which standardization of product should be carried as a programme for industry as a whole looms up in the fear of the effect on the worker of continued development of standard product. The group which have had this effect under consideration are not limited to labor leaders, social workers, or others who might be expected to think primarily of the welfare of the worker. Many forward-looking manufacturers have paused to consider whether they should adopt a programme of product standardization, lest they be unwittingly abetting the degradation of the worker. The point of view of those who oppose product standardization for this reason is that if the product be diversified, the worker tends to be a high-grade, skilled man, capable of diverse work. Such a man is likely to take interest and pride in his work and generally to be a useful citizen. As the product becomes standardized, the worker tends to become a low-grade machine tender, who does simple processes over and over during the day. There is thus apt to develop the type of man with little interest in the job, with practically no pride of accomplishment, and, in general, the type of worker who is easily swayed by movements leading to industrial or social unrest.

There can be no final answer given at this time to these contentions. However, every careful survey of the situation leads to the belief that such results cannot be laid at the door of product standardization. Although other fundamental conditions are far different, nevertheless the relative industrial unrest in the United States and England, the latter long the bulwark of diversified production, would be the first evidence against such conclusions. It is probable that such conditions as actually exist are due to the development of the factory system and machinery as a whole, rather than the development of this phase of management. The contrast is always made so as to draw inferences that conditions wherein a single workman makes a whole product may be brought back. Such is not the case. Even in extremely diversified production, the workman makes only his small portion of the product day after day. The difference is that he is making his small portion of a number of products rather than of a few. Besides, the skill of the old-type workman has been frequently over-estimated as the years roll by, and the newer workman has newer types of skill of which the old workman had none, such as skill in the manipulation of machinery.[1]

The change in type of workman with the standardization of product is a real one. As operations become automatic and repetitive, they can readily be performed by persons of less skill (even in machine operation). There can be no question but that the development of product standardiza-

[1] See article, "Skill," by Anna Bezanson, in Quarterly Journal of Economics, August, 1922.

tion means the future development of automatic machinery to perform the operations in the manufacture of the standard product. But the usual process is not one of degradation of the skilled workman, but rather elevation of the unskilled man into a semi-skilled job. Standardized product means cheaper product. Cheaper product means wider markets. Product standardization is thus one of the most effective steps which can be taken towards an increase of business by a manufacturing concern. The effect on the production of the Ford Motor Company which followed the standardization of its product is well known. Similar effects have followed every other successful attempt at standardization. Markets are expanded, luxuries made necessities, and jobs created for many more persons through product standardization.

Unknowing people have been heard to inveigh against the " degradation of the worker " in the Ford plant. But they are usually persons who have never been through the plant. It does not take an expert in management practice to see that most of the operators on Ford machines and assembly lines would be in the labor gang were it not for the extent to which their work has become standardized. Unskilled men have been made semi-skilled men at high wages. And what has happened to the skilled man? He has become the tool-maker or the supervisor. The demand for skilled men is greater than the possible supply, and this demand is also to be found in the vendor plants which sell the Ford Company's standardized parts. These skilled men are needed in numbers that would be unthought of, were it not for the huge production demands made possible by the standardized car. And so it is with the whole process of standardization. If all our wants had to be filled by the production methods of 1750, the products would be so expensive that our wants would be nearly as small as those of the people of 1750. Every step in betterment of productive capacity means wider markets and, in the end, employment of more skilled men.

Another answer to the objector to product standardization is the answer to the objection that it kills the worker's initiative. By working on the same work day after day, the worker really comes to know that job and that machine better than the man who first developed them. He begins to know enough to really make suggestions that are practical and can be utilized. The worker who, working on the same task day in and day out, cannot find play for his initiative in suggesting improvements has no initiative. There is a problem in insuring that the worker realizes his relationship to the industrial fabric as a whole, but that is true with division of labor under modern conditions, regardless of standardization. That problem will be discussed later in the chapters which deal with the personnel policy.

There is one last answer to the objections. The tasks of a very large share of workers in industries are so constructed that they have no rela-

tionship whatever to whether the product be standardized or diversified. To the man working around the dye-vat in the hat factory it makes little difference whether there are hats of a hundred or of nine colors made. His task remains the same and the technique of his job is not affected. The crew which stacks and fires the kiln in the plant manufacturing chinaware has the same problems and must go through the same work, regardless of whether 1130 or 330 patterns are made. Standardization of product only affects a small portion of the working force of any industry, and that they are not adversely affected has been shown.

CHAPTER XV

STANDARDS IN OPERATION

The meaning and value of standards in management. Standardization in management may conceivably only involve the standardization of the finished product, without regard to the standardization of any of the other features of the business. It is possible to make a standardized product from unstandardized material on unstandardized machines by unstandardized methods under unstandardized conditions. It is likely that the standardization of the final product will bring with it these other phases of standardization to a greater or less extent, regardless of whether or not the plant consciously strives for them. Nevertheless, standardization of the finished product is only one step toward complete standardization in a plant, and the other phases of standardization may be employed to advantage even if a plant produces an extremely diversified product, where even preliminary steps toward product standardization seem to be difficult.

Before discussing the various types of standards, it will be desirable to clearly define the word "standard." "Standard," under modern management, means a carefully thought-out method of performing a task, or carefully drawn specifications covering some phase of the business. These specifications may cover working conditions, equipment, or some article of stores, or finished product. The drawing of specifications includes the thought of the elimination of unnecessary duplication. Standardization does not imply that perfection has been reached. Nevertheless, after conditions or methods have become standardized, there usually follows a constant attempt to better the standards and raise them toward perfection. The standard is merely the best method, condition, or specification that can be devised at the time, taking into account all limiting factors. Improvements in standards are always desired and are adopted whenever they are found. Although there is nothing in the idea of standardization that precludes change, nevertheless standardization protects from changes which are not in the direction of improvement. Standards protect methods from change either for the sake of change or from the natural inclination to break away from set conditions through the usual laxity which may occur as work progresses.

To change a standard under modern management it should be necessary that the proposed change be scrutinized as carefully as the standard was scrutinized prior to its adoption, and further, that the change be brought about by persons as competent as those who originally framed the standard. Standards adopted and protected in this way produce the best possible results at any given time.

A standard is a base line for management. The setting of standards thus becomes one of the fundamental tasks in organizing a business for operation. The value of standards as base lines are fourfold. (1) They create a foundation upon which other steps of good management may be built. (2) The setting of them of itself causes a careful investigation to be made into all phases of the business. Without such investigation standards cannot be intelligently set. (3) They tend to aid routine operation of the business, and thus the development of a system and the application of the exception principle of management. (4) They reduce costs of operation in a way peculiar to themselves, thus making possible reduced costs to the ultimate consumer, as well as increasing the profits of the business.

Frederick W. Taylor said:[1] "It was in the course of making a series of experiments with various air-hardening tool steels with a view to adopting a standard for the Bethlehem works, that Mr. J. Maunsel White, together with the writer, discovered the Taylor-White process of treating tool steel, which marks a distinct improvement in the art. The fact that this improvement was made, not by the manufacturers of tool steel, but in the course of the adoption of standards, shows both the necessity and fruitfulness of methodical and careful investigation in the choice of much neglected details. . . . The economy to be gained through the adoption of uniform standards is hardly realized at all by the managers of this country."

The conditions in American industry with regard to standardization have improved since Mr. Taylor wrote the above. This is particularly true in some branches of the metal-cutting industry. Much of the improvement can be laid directly, and much more indirectly, to Mr. Taylor's work. In many other industries, however, the setting and maintaining of standards has scarcely begun, and there is everywhere much opportunity for study and improvement in conditions.

The discussion of factory working conditions in previous pages brought out constantly the necessity for the development of standards of lighting, of movement of material, of air conditions, and of other similar phases of the plant itself. Analysis of these points will show that in attempting to better these conditions in reality standards are being set. The discussion of product standardization or simplification has focused attention mainly

[1] Shop Management, p. 124. (Harper & Bros.)

on one phase of standardization, namely, the elimination of useless duplication.

Utilizing standard material. Analysis of the problems in standardizing material will give the first concept of the factors involved in applying the idea of standardization to operating phases of the business, as contrasted to organization or housing phases. It is impossible for operating problems to be properly worked out and solved if the material that is being worked upon is not standard and the composition of the material is not definitely known. Naturally, it is not always necessary that the best material be brought into the factory to be worked upon. To demand this would be to demand that the product of all factories be high-grade and that lower-grade products, to meet the demand of those with lower purchasing power, should not be put on the market. It will thus be observed that standardization, when spoken of in terms of materials, must necessarily take the form of standardization of type, regardless of whether that type be best or not, but mindful of the manufacturing necessities in the production of the finished product.

The standardization of raw materials directly affects the operation of three branches of any manufacturing enterprise: (1) the purchasing department, (2) the manufacturing division, and (3) the sales division. If the materials bought are standard, the purchasing department is better able to keep abreast of market conditions, is better able to place large orders and thereby receive lower prices and larger discounts. It is also better able to keep in touch with the demands of the factory for raw material, and, hence, to lessen the likelihood of a partial shutdown because certain raw material is not available. The manufacturing division, by knowing that its raw material is standard, is better able to set standards of performance for its workers, is better able to plan the routing of work through the plant, and is better able to plan standard methods of performance as well as amounts of performance. The sales division, knowing that the raw material is standard, can demand of the manufacturing department that their work be standard and is, therefore, in a better position to talk the merits of the completed article to the customer with a knowledge that the article when it is delivered will conform to all the promises that they have made.

In the purchase of raw material it is essential for the purchasing department to keep in mind that it sometimes costs so much more to work up a poor grade of material than it does a good grade, that, regardless of the quality of the finished product, the manufacturing costs on the poorer grade of material will be so much larger that they will eliminate all the prospective profits from the low price at which the material was bought. This simply demonstrates that the initial cost of any article does not necessarily bear any relationship to final cost.

In practically every industry there are to-day means of measuring, testing, and observing raw materials while in process, which were not dreamed of ten years ago. Much of the recent research work in industry has taken the form of finding out fundamental facts concerning raw materials. Therefore, the wideawake manufacturer takes full advantage of the investigations that have been made, and insures that all raw material which comes into his plant shall be suited to his type of product and to the type of machinery which he employs to work it up. Thus a metal-goods manufacturer learns just what type of metal he needs by making hardness tests on those metals which in practice give the best results and those that do not, recording all data carefully. In addition, he secures such outside data as are available. By doing this he may establish a standard. When he has established his standard and has based his specifications upon it, he should demand that the firm from which he is making his purchase live up to the specifications laid down. However, standards set must frequently conform to trade specifications, or the additional cost of materials will be heavy. In setting standards of materials, unless very large amounts are to be bought, it is ordinarily wise to choose between articles readily secured.

Standards of material purchased are too often set up on a basis of guesswork and too seldom on a basis of knowledge of the manufacturing necessities of the plant. The manufacture of cotton cloth gives an excellent example of the actual knowledge of manufacturing processes that is necessary before the standard of raw material to be purchased can be set. A poorer appearing cotton frequently proves better in the end. As an example, a mill was once operating successfully with a cotton which was slightly off-color, but it worked up well and the production ran smoothly. A new lot of cotton was brought to the superintendent's attention. He was given the choice of using this or the old grade. As the new kind was white and apparently free from foreign matter, and in general had a superior appearance, the superintendent was not slow in making his choice, particularly as the waste on the old grade has been somewhat high. But it proved to be a bad cotton to run. It had little strength, it spun with difficulty, and the waste exceeded that of the old grade. Had a few bales been purchased and put through service tests, this mill would have saved itself much trouble and money. So it is with many of the materials and supplies used in manufacturing. In addition to the laboratory test, which should be the initial test to which they are put, before any large orders for a new supply of product are given, it may often be wise to submit a sample of the prospective purchase to actual service conditions in the plant, and the measurement of the qualities mentioned in the standard must be agreed to between the vendor and the user.

Standards of material must be set and adhered to prior to studying methods of performing tasks or setting rates. It is clear that proper rates cannot be set if constant difficulty is encountered in working up material and if there are good and bad lots which alternately reach the same operation. Wage disputes in several industries, particularly the silk industry, have centered around this problem. If material be not standard, any attempt to place the workers on piece or bonus rates usually results in disaster. Failure to standardize material has frequently caused job studies, wage rates, and production control systems, otherwise well conceived, to fall into disrepute.

Methods of enforcing standards of material which have been set up will be discussed in the next chapter.

Utilizing standard equipment. Equipment must be thought of as everything, except material, with which the worker is provided to aid him in the performance of his task. As has been indicated, the building itself is the most important phase of equipment, but it is not usually referred to as equipment. Equipment ordinarily includes all apparatus assigned to production centers at which employees work, including workbenches or machines, and all tools, either separate from the machines, or fitted into them as particular jobs are to be done.

The importance of standardization of equipment is twofold. First, there is the economic advantage of greater production with the same effort, that may be secured through utilization of equipment suited to the task. Second, it is a basic preliminary step in standardizing methods of performing tasks and setting wage rates. It is impossible to determine how much work should be done by the worker or the best way of doing that work, unless the worker is provided with equipment, the possibilities of performance of which are uniform. The stories which " rate setters " in many manufacturing plants tell concerning trouble with belts, tools, etc., can generally be traced back to an absence of standards. Most of the injustice with which piecework has been charged is due to the lack of standards. It cannot be too clearly emphasized that many of the means used by managers to procure sustained production, such as proper production control and the newer types of wage systems, rest solidly on the initial provision of standards, both of equipment and of material. Men who aim to take short cuts in increasing production without attempting to standardize first, usually read failure into their efforts within the first few months of their experiments. The complaints of workers against so-called " scientifically " set rates can frequently be traced back to the fact that though the rates were properly set on the basis of the conditions as they existed at the time of setting, and as such were proper rates, these conditions changed, due to lack of standardization, and the rates were not correspondingly adjusted.

Workplace standardization. The meaning of workplace standardization can be best perceived by considering concrete illustrations. First, consider the results achieved in one of the better-known examples, that of the Herrmann–Aukam handkerchief factory at Lebanon, Pa.[1] In the department which folded the handkerchiefs, just before conditions were first changed, the equipment consisted of tables, about 4 feet wide and 30 feet long, the tops about 24 inches from the floor, running lengthwise across the factory, with an aisle at either end. The operators sat on both sides of these tables. Work was delivered from ironing machines in an ordinary box truck, from which it was taken and stored on any unoccupied table space, in boxes under the tables, or on chairs. It was given out to the operators by the forewoman in batches of from 10 dozen to 35 dozen at a time, the girls taking their completed work to the forewoman's table, and receiving their new work there.

Courtesy H. K. Hathaway.

FIG. 43.—Standard Workplace for "Ribboning" Handkerchiefs. Note the "spring chair" of proper height. Note the standard truck and standard carrying boxes to fit. Note the method of opening these carrying boxes, so that material may be placed therein most easily. Hermann-Aukam Co., Lebanon, Pa.

This company worked out a standard workplace for this folding operation, developing a workbench of just the right size, height, and slope of the top, permitting the operator to work equally well either sitting or standing. There are also two standard trucks provided, one to the left of the operator containing the handkerchiefs flat, as they come from the ironing machine, and one to the right to receive the handkerchiefs after they have been folded. There is a special open-side container in the truck for finished work, drawn out and resting on a proper shelf, at just the right height to receive the folded handkerchiefs and with the

[1] Adapted by permission from article by H. K. Hathaway on "Standards," Bulletin of the Taylor Society, Vol. V, No. 1.

hinged end let down so as not to be in the way of the operator's arm. After having folded sufficient handkerchiefs to fill one container, the operator places it in one of the truck's compartments, puts an empty one in its place on the shelf and takes another unit of flat handkerchiefs from the truck on the other side for folding. The trucks are moved to and from place by workers particularly designated for that purpose. Figure 43 shows a production center in the ribboning department of the same factory, indicating the application of the same idea to another department.

Standardized workplaces become of particular value in the assembly of small products, where a number of small components need to be conconstantly at hand, and where the position of these components exercises

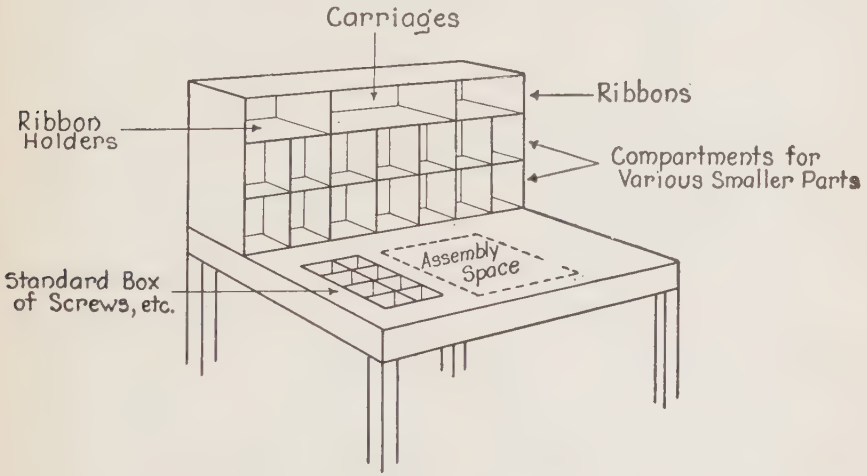


Fig. 44.—Standardized Assembly Bench, Corona Typewriter Co., Cortland, N. Y., Plant.

a large influence on the time of the operation. Among the plants which have developed exceedingly effective workbenches for this type of operation are the Champion Spark Plug Company and the Corona Typewriter Company. Figure 44 shows the workbench in the final assembly operation at the plant of the latter company and readily illustrates their development of this idea.

One feature of the standard workplace illustrated in Fig. 44 is the standard box of screws and similar small parts. Standard parts-carrying boxes for small parts are provided for all assembly operations at this plant and many others. One of the plants where this has been best developed is at the Philadelphia plant of the General Electric Company. Figure 45 illustrates such a box. A sufficient number of each part, for the assembly of the number of articles in the lot being manufactured, are provided.

If one part be used twice in the assembly, for instance, a screw of a particular size, twice the number of this part are provided. Much study may be given the arrangement of the divisions of the boxes, so as to entail the least labor in assembling. A similar type of box is the standard metal tote-box which has been developed to transport material from one operation to another. If these are of proper size they may be utilized for a standard number of each part. They are very sightly and durable and will nest one into the other when not in use, thus economizing both floor space and handling labor.

Standardization of the worker's chair, particularly from the standpoint of proper height, has been given much study. In a factory where the work permits sitting, it will be found that if the management has not provided chairs, the workman have improvised seats out of old nail kegs and packing cases, or have made themselves rough benches or stools. If

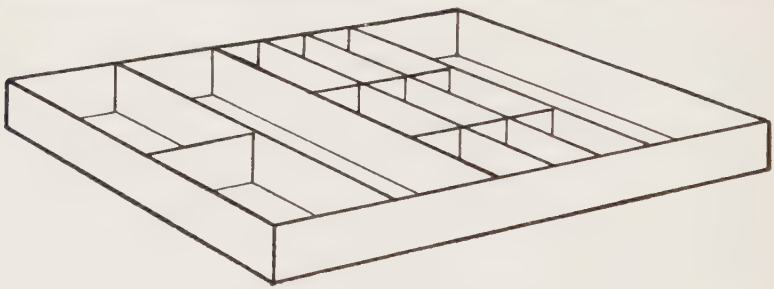


Fig. 45.—Standardized Box for Small Parts.

the chairs are really an aid to the work, they should be furnished by the management and as far as practicable these chairs should be scientifically standardized and suited to the purpose for which they are to be used. It is in the telephone exchanges that the importance of a proper chair has been, perhaps, most conclusively shown. Endeavors to improve and speed up the service have resulted in close attention being given to the proper type of chair, and the adjustable-height, back-fitted chair that is used in all exchanges to-day, was developed and has become an enormous aid in the handling of the great traffic passing over the large city switchboards.

The problem of finding the proper chair affords scope for considerable thought and ingenuity. For instance, to gain the advantage of sitting when the work requires moving about, the Waltham Watch Company has fitted with wheels the chairs of those who tend groups of automatic watch lathe benches. Close to and paralleling the benches, a rail has been laid which guides the grooved wheels on the front legs of the chairs while the rear wheels roll on the floor. But small effort is required on the part of the operator to pull herself along from machine to machine.

The proper height of the workplace and the chair depends largely on the nature of the work. Generally speaking, on heavy work, it is desirable to keep the lifting distance small. On the other hand, workers seated on ordinary chairs should not be required to bend too much; or when the material handled is quite light, it may be profitable to allow the height of workbenches to be determined by the machine-bed level of nearby machines. Transfer trucks or tables on wheels of the same height can then be employed and the bench hands provided with higher chairs. This arrangement has been found to be profitable in the finishing department of one large paper company and has expedited considerably certain operations which must be carried on both on machines and on benches.

One of the most satisfactory forms of commercial factory chairs, manufactured by the Royal Metal Manufacturing Company of Chicago, is illustrated in Fig. 46. The broad saddle seat, the adjustable legs, and the close-fitting back make this exceptionally effective. Footrests may be needed, but these can be readily attached.

Courtesy Royal Metal Manufacturing Co.

FIG. 46.—Standardized Commercial Factory Chair.

Standardization of machines. From the standpoint of the machinery manufacturer, machines are standard or special, depending largely upon whether they are general-purpose machines, to be sold to customers for a wide range of work, or machines which are constructed for some particular operation. Standardization of machinery, from the standpoint of the user, implies fitting machines to better perform the particular work which they have been assigned to do. There is thus some conflict between the desires of the machinery manufacturer, attempting to secure the economies incident to the standardization of his product, and the user of the machinery, anxious to secure the economies of operation incident to the use of machines especially adapted to the tasks to be performed. Some of the factors which will determine whether a manufacturer will utilize general-purpose or special machinery are: (1) The difference in

initial cost of the two, the general-purpose machine usually being cheaper due to the economies gained in its manufacture on a large scale. (2) The extent of standardization of product reached by the user of the machinery; the greater the standardization the more likelihood of the use of special machinery. (3) The likelihood of change in the manufacturing programme of the user of the machinery. Special machines, in addition to being expensive to build, do not have the resale value of general-purpose machines, and any decision to utilize them must be based on the assurance that they will be operated long enough to return more than the additional investment cost involved in their purchase. (4) The possibility of maintenance and part replacement; this factor is usually found to the credit of the general-purpose machine. Maintenance and part replacement is made easy rather than difficult, while the lower capital investment required in spare parts is only overshadowed by the saving in lost production hours which otherwise would occur from waiting for the arrival and fitting of replacement parts on special machines.

If special machines seem to be desirable, it is essential that a real study of the job shall be made, to insure that the machine about to be ordered is the best possible one that could be ordered at the time, and is not merely the result of a hasty idea that someone has worked out. Ill-thought-out purchases of special machines result in making the factory into a museum of discarded or little-used machines.

In attempting to apply the idea of standardization to machinery the costly error of over-equipment is likely to be made in order to secure like machines within a department. Thus a number of expensive machines, each of high capacity and expensive to operate, may be bought, whereas a few of this type of machine might suffice and other machines of smaller rated capacity could perform the remainder and larger proportion of the work at less cost. The advantage of flexibility of planning the work would have to be great, to overcome the investment and operation costs of the larger machines.

Regardless of whether standard general-purpose machines or standard special machines be utilized, there are a number of steps toward the standardization of the machinery to fit particular operations to be performed, which may be taken after purchase. One such step is to make inexpensive changes in pulleys or gears to better fit the machine to particular operating conditions. General-purpose machines must be geared by the maker so as to perform a wide range of duties, and if they are to be used on specialized work, it is frequently profitable to change their gearing. If two general-purpose machines of different makes are to be utilized on the same work it frequently will be found advisable to standardize their range of speeds and feeds, which may vary greatly.

The most general lack of remediable standards will be found in the speeds at which machines are operated. Frequently this lack of standards is due to the power-transmission lines. In mills where several lines of shafting drive identical machines, variations of as much as 10 per cent in the speeds of the line shafts are common. In some factories variations of 60 per cent have been found between the speeds of identical machines working on the same job. This is partially due to the variation in the speeds of the shafts, and partially due to the condition of the belting. The standardization of belting was held back many years, not because it was revolutionary or expensive, but merely because so many belting manufacturers and users were satisfied to proceed along the trodden path. The beginning of belting standardization came about when the belting manufacturers began to see that they were frequently supplying different sizes and grades of belting to different manufacturers to do exactly the same work. The belting manufacturers then began to investigate and ascertain which type of belt did the better work, thereby beginning a study which has resulted in the supply of standardized belting for nearly all transmission needs. All the requirements of power transmission fall into a number of sharply defined classes, for each of which a standard may be set up. Gradually, a belt engineering department was established by the larger belting manufacturers, and now the factory manager who desires to drive his machines from line-shafting has at his call, if he desires to use it, a whole mass of accumulated data, which gives him the necessary information as to just what standard belt he should use for any given purpose. Tables of belting performance have also been worked out by the belting manufacturing companies which may be taken advantage of by the factory manager.

Standard tools. Standardization of tools began with the experiments of Frederick W. Taylor at the Bethlehem Steel Company on the use of that commonly used tool, the shovel. He showed that workmen, to be most effective in their work, must have a type of shovel which peculiarly suited the material which they were handling. His experiments indicated that a shovel-load under ordinary conditions could best be handled if it consisted of about twenty-one pounds. It therefore followed that a shovel which was to be used in iron ore must be of a different size from one which was to be used for ordinary dirt, or a shovel which is to be used in moving coal must be smaller than one used for moving ashes if the twenty-one-pound load is to be secured in all cases. Everyone must realize that, to many people in industry, despite these experiments, a shovel is still a shovel. Frequently no particular attempt is made to see that the laboring gang is provided with different types of shovels, based on the material which is being worked on, or what is being done with it. Nevertheless, great strides have been made in numerous cases, and par-

ticularly in the contracting business there has been much attention paid to the proper type of shovel.

There is the choice, for instance, as to whether a long-handled or short-handled shovel is to be used on a given job. Practice has demonstrated that a man can shovel more earth with a long-handled shovel than with a short one, except under certain conditions where space is limited and short-handled shovels are necessary. For cutting down piles of dirt, unloading flat cars, or for other purposes where the shovel is used with a downward, instead of a sideways motion, the short-handled shovel is the ideal tool. In opening trenches it is usually advisable to use short-handled shovels until a depth of about 3 feet is reached, and then to change to long-handled ones. For digging work it is not a shovel at all that is wanted, but rather a spade. On the other hand, for working in sand, a spade would be relatively useless and a large shovel with slightly curved edges would be the best tool. These illustrations will serve to indicate some of the factors that must be considered in standardizing the tool on one of the simplest of operations, that of shoveling.

Turning to the usual types of factory work, it will be seen that there are two general kinds of tools used on most jobs, first, the auxiliary tools that are used in the preparation of the job and its removal from the machine and, second, the actual tools used as a part of the machine in the performance of the operation. The auxiliary tools will be considered first. In some shops they are considered to be about as humble as the shovel and as little susceptible of scientific study. To see a high-priced machinist, who operates a machine tool on which the overhead machine rate is also high, spend fifteen minutes trying to get a bolt ready to hold his work on a machine is the best possible argument for the standardization of auxiliary tools and for the practice of storing and issuing them to the workman along with the material to be worked on, as is done with the operating tools. Figure 47 illustrates proper storage of such tools.

Fastening tools in machine-shop work may be given much attention, not only to insure their being available when wanted, but also to see that they are of the right type and are in good condition. Frequently the preparation time for operations is almost as long as the time taken for the operation itself. Therefore, proper auxiliary tools, which are usually inexpensive, will quickly become real money-savers. All industries employ auxiliary tools, such as wrenches and screw-drivers, which can be readily standardized.

One of the greatest profit-making auxiliary tool types is the jig, or fixture used to guide operating tools, particularly drills, so that their operation shall be the same on each piece. Careful analysis of production methods will usually provide the stimulus for jig development, particularly if an operation involves any cutting or drilling. A similar illustration is

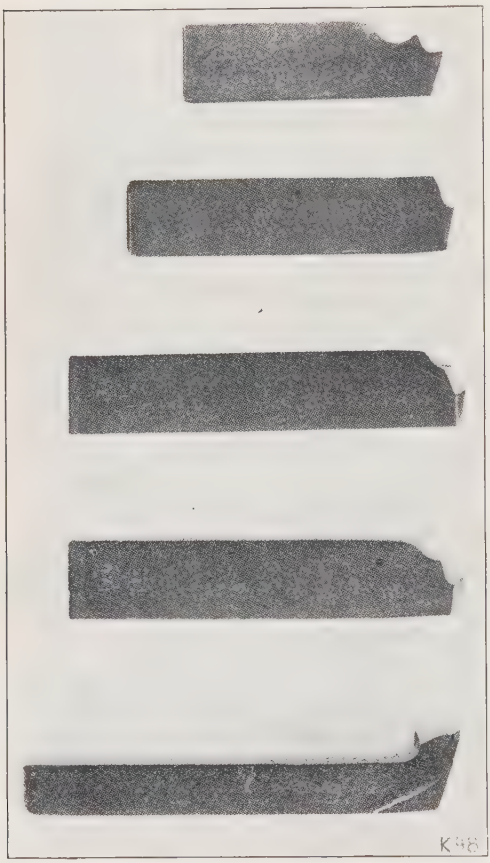
to be found in the clothing industry, where in the cutting operations, the familiar patterns have been amplified in some plants by designs, showing how they may be best laid out on cloth of different widths, to best conserve material. In metal-cutting, considerable ingenuity is frequently called for in the design of jigs. In one plant it was found necessary to drill five holes of two different sizes on two sides of the same piece of metal. A two-spindle drill was used. Small one-piece jigs were designed that fit over two sides of the piece of metal. The operator first places the jig over the piece, then quickly places the piece under the spindle holding the larger drill, drills three holes, then, without moving the jig, places the piece on its side under the other drill, drilling two more holes. All five holes are quickly and correctly guided by the jig, which he now removes and places over the next piece to be drilled.

Courtesy H. K. Hathaway.

FIG. 47.—Section of Toolroom, Showing Standard Woodblocks Stored in Standard Bins.

The operating tools in a machine shop consist of cutting tools that go into the machine and which are changed with each type of job which is put into the machine. The composition of these cutting tools varies greatly, and was completely revolutionized some years ago with the discovery of high-speed steel. New inventions are being perfected yearly, and it is not at all uncommon to find a number of types of tool steel in stock in a shop. The mere presence of a large variety of types of tool steel in a shop is not at all bad, in fact, it may be very desirable. However, some steps must be taken to insure the use of tool steel of the proper grade on each job. To leave this to the workman is to leave it to guesswork. Many shops can still be found in which tools made from a dozen different qualities of steel are used side by side, in many cases with little or no means of telling one make from another. When one realizes that the cutting speed of the best air-hardened steel is, for a given depth of cut,

feed, and quality of metal being cut, say, 60 feet per minute, while with the same shaped tool made from the best carbon tool steel and with the same conditions, the cutting speed will be only 12 feet per minute, it becomes apparent how necessary is careful attention to the utilization of the right tool on the right job. Carbon steel tools are still used for many operations, as in accurate finish-cuts.



Courtesy H. K. Hathaway.

FIG. 48.—Lathe Tools (Side View). The bottom one is standard tool-machine ground; the others unstandardized-ground by hand of workmen.

Tools are different, not only in composition, but in the method of grinding. The cutting edge was in past years largely put on the tool by the workman at the job, and he was accustomed to grind this edge entirely with respect to his own whims and prejudices. It can readily be seen that to use a tool ground the wrong way is quite as bad practice as to use a tool of the wrong composition. There is a certain shape of tool best adapted to each individual kind of work, and the tool should be ground at certain definite angles which have been found to be the best by a long series of experiments. It is obvious that if all tools are to be ground to these correct angles, the grinding of them must be taken away from the men in the shop and placed in the hands of a man in the tool room. Figure 48 shows the wide variations found in cutting tools used for the same job in one shop, compared with a tool for that job properly ground to conform to best practice.

In weaving, much attention can be given to shuttles, to insure that they are standardized. The use of shuttles of different weights, with the same speed of the loom, produces a variation in the tension on the filler thread. Smashes and stoppages in production may often be traced to

this cause. Shuttles must not only be of standard type, but kept in good repair. In spinning and weaving, the speed at which the machines can be run will be found to vary with the product being manufactured and the quality of the material. Studies may be made which will give the proper operating speed, in picks per minute, for each type of fabric being woven. A pick counter, mounted on the machine, will materially aid in securing this information.

The tool room. The establishment of a tool room with complete jurisdiction over tools is the usual means of insuring the continuation of tool standards that have been set. Such a tool room has the following functions: (1) the provisioning or manufacture of tools (on the basis of planning or methods department specifications); (2) the storage of tools; (3) the issue and receipt of tools; (4) the repair and maintenance of tools; (5) keeping tool records. The tool room does not decide what type of tools are needed, except in an advisory capacity. This must be determined by those who study the requirements of the operations. The tool room does manufacture or provide, through the purchasing department, an adequate supply of each type of tool which has been approved for use.

It is not desirable here to take up the method of storage of these tools in detail, because that is not dissimilar from other storage problems considered later under store-room practice. Suffice it to say that a stock of tools of ample quantity must be kept on hand and ready for issuance when needed, and that these tools must be issued to the workmen and returned from them before and after the jobs are performed. Due to the necessity of tools being always in good repair, and, in the case of cutting tools, ground exactly correctly, the maintenance end of the tool room is by no means the least important section. An inspection bench, a repair bench, and grinding machines must be allowed for in the layout of any tool room. Adequate inspection and prompt repair or regrinding of tools will always insure that the tools which are issued to the shop will be entirely up to the standard that has been set and will eliminate the possibility of those losses which have been shown to be incident to the use of unstandardized tools.

A check system is usually utilized to account for and locate all tools. Workmen, upon being employed, are provided with a stated number of tool checks, which they send to or leave at the tool room each time a tool is withdrawn and which are returned to them when the tools are returned. Other checks are provided for tool-room use, which are placed in the usual location of the tool whenever it has been sent to the grinding room, or other disposition has been made of it. Tools are issued to the shop only on request of the foreman or order from the planning department, depending upon the system in operation. In either case a check must be received from the workman to be placed at the usual location of the tool, and a

record is instantly available concerning the location of the tool. Tool-room operation is very closely connected with planning department operation, inasmuch as the latter, in planning for production, must always determine whether the needed tools will be available, considering the other jobs then to be in process. Accurate tool records will be essential for such close figuring. However, if the check system of issuing tools is utilized, such a record will always be available, inasmuch as every tool should be easily accounted for, either by checks or tools.

CHAPTER XVI

MAINTAINING STANDARDS—THE INSPECTION DEPARTMENT

The maintenance of standards of material or of product is largely in the hands of the inspection department. The inspection department is in a peculiarly favorable position to effect large savings in operation through vigilant upholding of standards which have been set.

If the inspection department must uphold general standards of manufacture, as provided for by the manufacturing policy that has been adopted, this implies not only the mere upholding of standards of materials or product, but also the upholding of standards of exactness which allow for interchangeability in manufacture and for proper handling of later processes and operations. This responsibility which is placed on the inspection department is very likely to cause the inspectors to be looked upon by production men in the light of opposing forces. Unless careful consideration be given to methods of operation, the inspection department and the quantity production group are very likely to become bitter plant enemies.

Location of the inspection department in the organization. As has been pointed out in Chapter VI, an inspection department must never be made directly subservient to the will of those who are engaged in increasing the quantity of production. Unless quality of work is but a very small factor in the successful operation of a plant, the following scheme for the location of inspection work should be avoided.

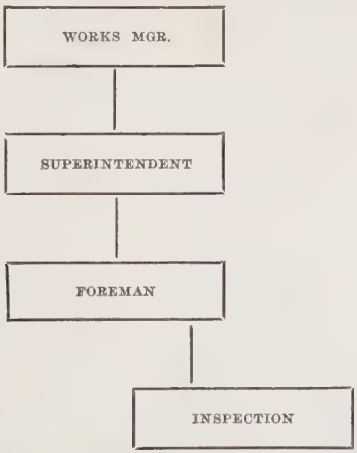


Fig. 49.—Bad Location of Inspection Department in Organization.

If the foreman has charge of inspection work, manifestly he cannot be expected to be rigorous in his application of manufacturing standards and, at the same time, be forcing quantity production through his department. This does not mean that the foreman should not be interested in quality. Means should be provided to see that quantity production should not be credited to a foreman unless quality is good. On the other hand, decision as to quality must be taken out of his hands.

If quality is not of excessive importance in an industry, inspection forces may be well maintained as a staff department under the superintendent, as illustrated in Fig. 50. This places the foreman in a position

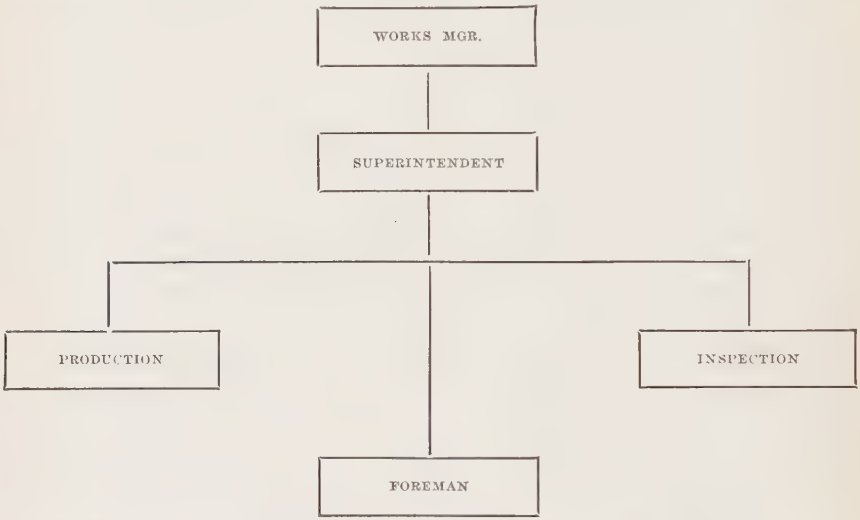


Fig. 50.—Location of Inspection Department. If Quality not of Excessive Importance.

of receiving instructions, as to amount of product to be produced and the quality of that product, from two sources. He must endeavor to correlate his instructions and, in case of conflict in instructions, the matter will naturally be referred to the superintendent for decision.

If quality is of maximum importance, as in the case of production of scientific instruments, or in goods which are sold mainly on the basis of quality rather than on the basis of price, the inspection department should probably become a major manufacturing function directly under the control of the works manager (Fig. 51). The inspection function would thus hold a position analogous to that of the purchasing department or the engineering department on the typical organization chart (Fig. 4).

The inspection department can be most helpful when it endeavors to prevent errors in manufacture, rather than criticize results and turn

back defective material for reworking or scrap. Though all errors cannot be corrected prior to their occurrence, if the inspection department will practice preventive medicine on the product, not only will it become a dividend-paying portion of the organization, but it can more readily co-operate with the quantity subexecutives. The inspection department is an effective aid to the foreman, planning department, the training department, or the methods department, whichever of these may direct the methods of operation and instruction of the worker. If instruction as to causes of defects be made a major function of the inspection department, the idea of carrying on the preventive medicine campaign will have been greatly furthered.

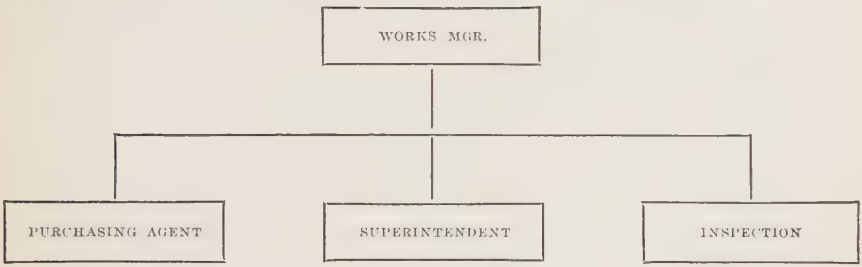


FIG. 51.—Location of Inspection Department. If Quality of Maximum Importance.

The inspection department should have full control, both over inspection of purchased materials and parts, and over inspection incident to production. The first of these enables it to maintain the material standards which have been set, and the second makes possible the maintenance of product standards. Frequently the work of inspection incident to production will closely approximate the type of inspection on purchased materials. An instance of this is found in the case of a part to be made from soft steel for economical working, and then to be hardened and tempered to fit it for the service requirements of the finished product. This illustration should indicate the necessity of an inspection department having full control of all inspection operations.

Inspecting materials. Material purchased according to standard or specification must be inspected before acceptance. In some plants the foreman who is to use the material is required to inspect it, while in others a complete laboratory is at hand under the control of the inspection department. The inspection department, in general charge of quality of the product, is the logical place to have this inspection performed. Numerous items, such as electric-light bulbs, warrant only a casual inspection to find whether there are any broken or defective parts, and this is often taken care of by some member of the receiving department. In many instances, however, the inspection should call for checking as to quantity,

weight, quality, and workmanship. The best intentions of the purchasing department may be rendered void without an adequate inspection system. For example, the dimensions and weight of bar steel are easily arrived at, but the question of quality can only be truly determined by laboratory test. Many examples could be cited where chemical or mechanical tests are essential to ascertain whether stores are in keeping with the standard ordered. It is but natural that certain material may pass the original inspection and yet develop defects during the course of manufacture. A record should be kept of such instances with a full description, so that adequate tests may be provided the next time to detect the defects before the material enters the factory. It is a costly practice to allow material to be worked on in the factory before the weaknesses are discovered.

Manufacturing inspection. Inspection problems in assembly industries are somewhat different in character from inspection problems in continuous industries. In the latter, the general problem of manufacturing inspection is to develop good quality in the final product. Frequently the purpose of the inspection work is to rate the product as to quality after it is produced. In continuous industries, such as the manufacture of paper, textiles, or chemicals, a defect in manufacture is likely to make the material a " second," and there is frequently no possibility of correction of the defect. Thus the operation of an inspection department in such industries includes the prevention of defects wherever possible, the noting of defects after they have occurred, and the decision as to whether such defects may be remedied or whether the goods must be placed in the lower classification of product.

In assembly industries inspection includes attention to accuracy of manufacture and to interchangeability. The American system of manufacture has been erected on the basis of interchangeable parts. Although the consumer is likely to look upon interchangeable parts from the standpoint of possible availability for repair purposes, this is a very minor consideration. From a production control standpoint, as well as from the standpoint of the assembly operations, this interchangeability of parts in assembled products is essential in order that specific parts, when started in manufacture, need not be designated as being for specific pieces of final product. Thus, in the manufacture of watches, from the consumer's standpoint the interchangeability of parts is important in those parts which become broken, such as springs. Nevertheless, this is of but small benefit to him contrasted to the benefits resulting from lower cost of manufacture due to the manufacturing interchangeability of practically every part in his watch, although some of the parts, because of their nature, will never need replacement during the life of the watch. Inspection of components during process affords the inspection department an especially good opportunity to practice preventive medicine in assembly

industries. In some industries, inspection is so important for the following operations and for the maintenance of product standards that it is regarded as a process in the manufacturing cycle.

When, how much, and how to inspect. The three major problems which face those who are determining the methods of operation of an inspection department are when to inspect, how much of the product to inspect, and how to inspect. Decision as to when to inspect cannot be made without reference to the importance of quality in the product. Certainly, inspection must be made as a final operation when the product is finished and ready to be shipped to the consumer or sent to stock. Perhaps inspection must be made after each operation. Between these two extremes lies the usual situation. In assembly industries all goods must be inspected prior to the assembly processes in order that the time of workers engaged in these processes may not be taken in the rejection or fitting of parts. Usually, except in cases of high-quality standards, a series of operations in manufacture can be satisfactorily grouped and inspection made only at the end of these groups of operations.

In high-quality products, or products which are manufactured largely through skill of the worker rather than skill of the machine, much more of the product must be inspected than in the case of lower quality product or in cases where the machine, once set up, is likely to turn out standard quality products for a considerable time without adjustment. In the latter case, inspection must be made frequently enough to ascertain that the equipment is operating satisfactorily and does not need adjustment other than the usual adjustment made by the worker on the job. In the former case, frequently 100 per cent inspection will be necessary, that is, every unit of product must be inspected after every operation. Inspection department operation is facilitated through the development of an inspection code which is known to all concerned. This inspection code, which should be developed in writing if possible, should indicate the standards which are set up and also should indicate to the inspector the most frequent causes for defects in manufacture. A code should be rigid as to requirements, but the requirements should be reasonable in order to secure the co-operation of others in the production end of the organization. The inspection code, of course, becomes in a sense the code of the organization with respect to standards of material and of product. This code aims to clearly indicate the manufacturing standards, which may differ by certain differences or allowed errors from the standards as set up in the design or engineering departments. Although the latter department may indicate tolerances on its specifications, nevertheless there can be frequently set up in the inspection code the practical application of these tolerances.

Manufacturing tolerances should be set up with great care in order that

unnecessarily high precision, and attendant high manufacturing costs shall not be required. Carefully studied tolerances will prevent these wastes of unnecessarily high precision. But the limit, as set up by the tolerance, should not be looked upon as the dimension or quality to aim at. Many manufacturers have frequently made the mistake of working to outside limits, with large rejections as the result; in other words, they have aimed at the outer circle of the target, rather than at the bull's-eye. Although the shot will count if it hits the outer circle, nevertheless it will more frequently hit the target if the bull's-eye be aimed at. The best workmen in plants with the best production and inspection policy will hit the bull's-eye often, and they will not require decisions of the Supreme Court of the manufacturing department to determine whether or not operations which they have performed fall within the tolerances which have been set up.

Any inspection system should certainly provide for tracing defects to the individual worker who caused them, and should provide some means of insurance against their recurrence. Such methods tend to make workers their own inspectors, make possible the reduction of the inspection force, and provide for the smoother flow of materials through the manufacturing processes. Such a system should be tied up with some scheme of reward for quality or penalty for failure to reach standard quality, as is explained in the chapters on wage payment, and particularly Chapter XXVI.

In general, the inspection department must be constructive in its operation. It must not only reject, but it must show the causes of rejection, and it must work with and through the foreman in attempting to eliminate these causes of rejection. Disputes between the inspection department and the manufacturing departments cannot be avoided, but they can be minimized. They cannot be avoided because the inspection department is in reality absorbing all the difficulties which, were it not for its presence, would become interdepartmental disputes. Those plants which have large numbers of interdepartmental disputes between manufacturing departments concerning the quality of workmanship on material passed from one department to the next are usually plants in which the inspection department is not functioning effectively. Disputes between manufacturing departments and the inspection department may be minimized through taking two main steps. These are: (1) setting reasonable, definite, and measurable standards of quality variation; (2) using measuring devices of such precision as to render the method of determination of these quality factors acceptable to both parties.

CHAPTER XVII

STANDARD NOMENCLATURE

Classification and symbolization. The development of standard nomenclature within a business for all the items in each of the various phases of the business involves two steps, (1) the development of a classification, and (2) the assignment of standard symbols for the articles classified. A classification is a detailed, orderly arranged list of all the items pertaining to the various phases of a business. Classification, under modern business conditions, is a necessity, and the merits and results of classification should not be confused with the merits of the various systems of symbolization which make the classification usable in the day-by-day operations of the business. Symbolization is the assignment to all classified items of a series of related characters, in such a manner as to aid in the recognition of the item and to definitely fix its identity separately from all other items in all phases of the business. To secure proper results from a classification, the use of mere names is not sufficient. A name may mean more than one thing at the same time and in the same place, and in many cases names are ambiguous even when referring to articles of a similar nature. Hence, the requirements of good classification demand something more accurate, shorter, more concise, and less ambiguous than names or words. Such requirements are met by the use of symbols.

The beginning of classification work within a business usually marks the beginning of accurate knowledge concerning the various phases of the business and their inter-relationships. It was previously pointed out that one of the operating fundamentals of good organization is the establishment of a complete and accurate set of records which will serve as the basis for action. These records must be obtained in a way which will permit those in charge of the work to collect the desired information rapidly and be assured of its completeness and accuracy. When one considers the number and variety of records that are necessary in the modern organization, it becomes apparent that a definite classification of the data pertaining to the various activities is necessary. Otherwise, there is likely to be duplication and overlapping of work in the collection of such data. The establishment of standard nomenclature within a business makes possible the establishment of a system which makes record-collection routine. In this and innumerable other ways, the development of standard nomenclature

is a highly important part of the creation of an effective system within an organization.

The uses of standard nomenclature are:

1. It clearly indicates the plan of organization, in that it shows the relationship of divisions and departments, and interprets the limitations of their activities.
2. It establishes a method for obtaining the information necessary for the operation and control of an effective accounting system, because it facilitates the collection of data pertaining to indirect expenses and manufacturing costs, and aids the establishment of monthly inventory balances of Stores, Material in Process, Worked Material Stores, and Finished Products.
3. It aids in standardizing the arrangement of articles in storerooms and prevents the incorrect issuing of articles, which often happens when names or shop terms are used on the requisition.
4. It furnishes a means for routing and controlling material in process by accurately designating the materials, machines, workplaces, and operations entering into each process or component.
5. It makes possible the collection of detailed information relative to buildings and equipment.
6. It provides a logical system for the filing of all data.
7. It aids the development of standardization. The word is here used in the special sense of the determination of the best method or the best material to use for any given purpose under existing conditions, and strict adherence to that best as a standard until a better standard is found. The necessity for standards in order to facilitate and cheapen production has been previously pointed out. Classification aids in this because in almost every instance in which classification is applied, it will be found that there are a large number of almost similar articles used for similar purposes. In order to reduce the amount of classification work, to say nothing of other reasons; there will be a tendency to reduce the number of items. This helps to create standards. When it is ascertained that an item is the best, it is adopted, classified, and recorded. The advantages of standardization alone will often more than cover the cost of classification, because the mere reduction in diversity of stores, products, or machines to a comparatively few standard ones is an economy of apparent value.

There have been a number of effective methods devised for the development of classification symbols, some of which are in common use. The two main methods utilize, as the base of the symbol system, numbers or letters. Both methods frequently use the main device of the other to aid in the expression of particular conditions. Methods utilizing numbers may be again divided into straight numerical systems, and Dewey Decimal Systems which express relationships by the positions of numerals to the left or right of the decimal point. Both are developed along essentially the same lines. Methods which are based primarily on the use of letters are ordinarily called mnemonic, because they are designed with the primary idea of having the symbol easily remembered. It should be borne in mind that a symbol system is not a classification, but merely a method of expressing or designating the classification. Furthermore it should be observed that most classifications must go through several revisions before they are found to be logical, especially when expressed in symbols, and that compromise is the basis of the art of working out of standard nomenclature. Deviations from a strictly logical series of symbols are often necessary to preserve a logical classification, which is more important. Effective symbols should be as short as possible, should be absolutely definite, so that one symbol can mean one and only one thing, and should be as mnemonic as possible.

Steps in developing standard nomenclature. The first step in the development of standard nomenclature is to build up the classification. This involves the logical grouping of all like items in the business. First, every element of the business must be listed with infinite detail, taking into consideration all existing departments, all materials in stores, and in process, all finished products, all workplaces and machines, all operations performed, all fixtures and tools, all buildings, and all possible sources of expense. After the preliminary data have been gathered, the subjects to be classified are divided and grouped into a number of main classes, each of which is designated by either a number or a letter, depending on the method used. Each main group is then subdivided or further described to the extent that is necessary. After each group and subgroup has been formed and carefully revised, the attaching of symbols to each item may be begun.

The cost of classification is heavy, although the return on the investment is large. Therefore, care should be taken to classify and symbolize no more of the business than will actually be daily utilized when the standard nomenclature has been built up. There are certain fundamental features of classification which can be used in almost every case, but there are others in which nicety of judgment must be exercised before deciding whether to incorporate them into the original classification or not. For instance, almost every plant has need for some control over its raw

materials or parts in process in the storeroom. To secure this control it is necessary to establish a requisition method of withdrawal from the storeroom. As soon as this is introduced, standard nomenclature generally becomes a very useful mechanism, both for the location of the article itself in the storeroom, and for the abbreviation and simplification of the clerical work attached to the writing of the requisitions.

An example of when not to use too much classification occurs in almost any of the continuous or analytical industries which handle a single material from start to finish. In such a case an elaborate classification for routing, including identification of all materials in process, finished product, machines, and workplaces, might be expensive, burdensome, and unworkable. On the other hand, a highly involved assembly industry is lost without a good routing classification. The classification of duties and functions of individuals has not been carried as far as the classification of the other branches of industry. In a good functional classification, the duties of every individual in the organization are included in the classification in such a way that they are easily understood, and furnish the basis for other classifications used.

A classification should be made as simple as possible. Care should be taken not to subdivide the main groups any more than is actually necessary; otherwise, the symbols will be long and possibly unwieldy. Nothing should be included in the symbol that does not serve a definite purpose. On the other hand, the simplification of the classification should not be carried to such an extent that confusion or misunderstanding will result. The possibility of having to expand the classification in the future, due to a growth of the plant, should be borne in mind when the original classification is made, and provisions should be made to take care of such growth. Otherwise, the development of a new classification may be necessary, thereby incurring unnecessary expense and inconvenience in the operation of the business.

After a classification has been completed, it will be well to bear in mind that many unforeseen " kinks " will probably develop, and provisions should be made to quickly investigate and correct any trouble. A classification is useful only to the extent to which it is kept up to date. An accurate record of all persons holding copies of the classification should be kept, so that when changes are made in the original classification, arrangements can be made to have all additions and changes entered on all copies. This can best be handled by the Methods or Research Department, if one exists.

Numerical symbols. The numerical system of symbols is used in a large number of businesses. With this system, the symbol may consist of one or more separate numbers. For instance, expense items are frequently designated by indicating the number of the unit of the business

incurring the expense, followed by the symbol representing the expense. Whenever this system is utilized, a block of consecutive numbers is usually assigned to each general class into which the activities of the business are divided. The advantages of the numerical system are: (1) its seeming simplicity at first glance, (2) its ready adaptability to use in connection with tabulating machines, (3) its particular simplicity when only accounts are classified. This last factor is the cause of the almost universal adoption of the numerical system when only accounts are classified. The disadvantages of the numerical system, compared to the use of letters (usually termed the mnemonic system) are the following: (1) it is difficult to associate the symbol with the item classified, which factor is particularly important in items of stores, product, etc.; (2) each position in the symbol only gives the possibility of 10 class divisions, while there are 22 in the case of letters; (3) because of the use of numbers for all purposes, sizes cannot be readily shown in the symbol; (4) in stores or production control work, the symbols tend to become extremely lengthy; (5) it is difficult, if not impossible, to develop a series of symbols to cover all the items in the business without repetitive numbers. These disadvantages are somewhat modified in cases of the manufacture of standard product, where the number of items to be classified is somewhat less. The Dewey-Decimal System has essentially the same advantages and disadvantages as the straight numerical system, except that the advantages gained are somewhat less and the disadvantages are somewhat more pronounced. Though excellent for library and general filing work, this system is not well adapted to standard nomenclature work in business, especially in manufacturing enterprises. The following is an example of the development of a numerical system of symbols:

DEPARTMENT NUMBERS (1-199)

Executive Department (1–9)

1. President's Office
2. Vice President's Office
3. Treasurer's Office
4. Secretary's Office

Comptroller's Division (10–19)

11. Credit Department
12. Accounts Payable Section
Etc.

Sales Division (20–29)

21. Domestic Sales Department
22. Export Sales Department
23. Sales Promotion Department
Etc.

Purchasing Department (30–39)

31. Quotations Section
32. Price Record Section
Etc.

General Office (40–49)

41. Stenographic Section
42. Mail Section
Etc.

Personnel Division (50–59)

51. Employment Department
52. Employees' Service Department
Etc.

ENGINEERING DEPARTMENT (60–69)

61. Design Section
62. Inspection Section
Etc.

MAINTENANCE DEPARTMENT (70–79)

71. Machinery Section
72. Equipment Section
Etc.

SERVICE DEPARTMENT (80–89)

81. Finished Stock Section
82. Shipping Section
Etc.

STORES DEPARTMENT (90–99)

91. Raw Material Section
92. Worked Material Section
Etc.

PRODUCTION CONTROL DEPARTMENT (100–109)

101. Planning Department
102. Standards and Methods Department
Etc.

MANUFACTURING SHOPS (110–199)

111.
112.
113. Machine Shop
114. Milling Department
115. Drilling Department
Etc.

ASSET ACCOUNTS (200–299)

PLANT (200–224)

201. Land
202. Buildings
Etc.

EQUIPMENT (225–234)

226. Machines
227. Motors
Etc.

MATERIALS AND SUPPLIES (235–259)

236. General Supplies
237. Raw Stock
Etc.

CURRENT ASSETS (260–271)

261. Cash—General Funds
262. Cash—Cashier's Fund
Etc.

INVESTMENTS (272–279)

273. Sinking Funds
274. Contingent Funds
Etc.

PREPAYMENTS (280–289)

281. Prepaid Insurance
282. Prepaid Taxes
Etc.

LIABILITY ACCOUNTS (300–399)

FUNDED DEBT (300–309)

301. Bonds
302. Coupon Notes Payable
Etc.

UNFUNDED DEBT (310–329)

311. Bills Payable (Notes)
312. Accounts Payable (Vouchers)
Etc.

RESERVES (330–349)

331. Capital Stock Premium (Full Paid)
332. Capital Stock Premium (Subscribed)
Etc.

CAPITAL STOCK (350–359)

351. Capital Stock Common
352. Capital Stock Preferred
Etc.

SURPLUS (360–365)

361. Surplus
362. Undivided Profits
Etc.

REVENUE ACCOUNTS (400–499)

401. Profit and Loss
402. Manufacturing
403. Sales
Etc.

EXPENSES (500—)

501. Salaries—Executives
502. Salaries—Clerical
503. Commissions
504. Retainers—Premiums, Bonuses
505. Idle Machine Time
506. Supplies
507. Postage
508. Telephone and Telegraph
509. Legal
510. Consulting
511. Traveling
512. Entertaining
513. Miscellaneous Labor Cost
514. Janitor Service
515. Material Handling
516. Crane Operators
517. Watchmen and Gatemen
518. Drivers and Chauffeurs
Etc.

In the utilization of this classification, departmental expense symbols are formed in the way that the following examples indicate:

23—(502) Sales Promotion Department Clerical Salaries
23—(511) Sales Promotion Department Traveling Expenses
114—(505) Milling Department Idle Machine Time
114—(516) Milling Department Crane Operator Expenses

At times, when the symbols are short, as when the expense symbols are lower numbers, the symbols are written as one number. An example of this would be 2302, Sales Department Clerical Salaries. An effort to write these symbols in this way usually results in confusion, because ordinarily the same symbol for two or more items, as a department and an expense, cannot be avoided.

Numerical symbolization of material is extremely common, and is especially valuable in cases of the manufacture of a few standard products for which standard materials are utilized in manufacture. In such cases, effective numerical stores symbols can be built up. Although there is nothing in the symbol itself which recalls the article referred to, nevertheless, constant association of the symbol and the article soon makes possible the prompt association of the article and the symbol name by those who daily utilize the symbols. An example of a stores classification, numerically symbolized, is not given, since it merely involves the numbering of the articles of stores and product in sequence, after they have been classified.

In plants manufacturing diverse products it is extremely difficult to build up a simple and effective series of numerical symbols for stores. Symbols soon become involved; and since they do not readily recall the article they describe, and, furthermore, usually duplicate other numerical symbols used in other phases of the business, some form of mnemonic sym-

bol is usually adopted. As an example of the manner in which numerical stores symbols become readily involved, the following symbol used by a paper-manufacturing plant is given: 801 2-3-0 5-16. This symbol was used to designate coupon bond paper, loft dried, second quality, glazed finish, weighing 16 pounds to a folio.

Machines are ordinarily symbolized by an arbitrary assignment of numbers to classes of machines and individual units within the class. The first two numbers usually indicate the class of machine and the last two the machine number within the class, as shown by this example:

0501—Automatic Feed Turret Lathe,	1
0502—Automatic Feed Turret Lathe,	2
0601—Automatic Chucking Lathe,	1
0602—Automatic Chucking Lathe,	2
0603—Automatic Chucking Lathe,	3
0701—Chucking Lathe,	1
2601—Horizontal Milling Machine,	1
2901—Gear Cutter,	1
2902—Gear Cutter	2
3601—Plain Vertical Milling Machine,	1

Some plants put department numbers in which the machine is located as first digits in the number of the machine. This is inadvisable, since when machines are moved from one department to another the symbols not only cease to have any meaning, but are confusing.

Mnemonic nomenclature. Probably the best type of nomenclature yet devised, which meets all requirements in practically every case, and is of great practical value, is the system based on the use of letters with the aid of numbers, commonly called the Mnemonic System. This system was worked out by Frederick W. Taylor and his associates, and their pioneer work in nomenclature stands as the best single contribution to classification and nomenclature work in American industry. One of the most valuable phases of this type of nomenclature is that a system can be devised to classify and symbolize every single phase and item of a business in a way that makes the nomenclature a unified whole without repetition of symbols. However, in any business, only those items for which there is need of standard nomenclature need be classified and symbolized.

This system is based on a complete and exhaustive analysis of every detail of labor, materials, and organization involved in a business. All the elements are divided into logical groups, first into broad general divisions and then into subdivisions, groups, sections, subsections, and so on. Letters are used to designate each division, subdivision, group, etc. Where possible, the letter chosen is the initial letter of the name of the item or some significant letter in the name. Numbers are used to designate dimensions, job numbers, or lot numbers, depending on their place in the

symbol. Numbers are also used to designate different items within a class. If there were eight or nine kinds of plain office pencils in a storeroom, numbers would be used to designate the various kinds instead of going to the detail of adding a letter for each variety. With this last condition as an exception, letters and numbers are thus, wherever possible, suggestive of that which they represent.

Since one classification and system of nomenclature is to be provided for all items of the business, a base sheet can be drawn up indicating the first letter, or main classification, of each phase or item of the business. Such a base sheet is shown as Fig. 52. This base sheet indicates that the various activities of the organization have been grouped under three main heads: B, Business Division (including Personnel); C, Selling Division; and D, Manufacturing Division. In case some other phase of the business is made a main division, it, too, should be given on this base sheet, a primary letter to designate it, as E, Engineering Division. A is reserved for the General Accounts of the business, X is reserved for all tools, Y for all machinery, and Z for all buildings. These last three letters may represent either the physical item or the account covering this item. No confusion can exist here because of the absolutely different usage involved. The letters from F to W inclusive are reserved for products, with the exception of S, which is reserved for Stores or raw material. Semifinished material is represented by subdivisions of the product symbols, F to W. This reservation of letters will apply only to the first letter of a symbol. The letters I, O, Q, and U are never utilized in mnemonic classification, since the first three are likely to be confused with numerals and the last is likely to be confused with V.

General accounts, represented in the main classification by symbols beginning with A, may be symbolized as illustrated by the following example:

General Accounts

AA	Revenue Accounts	AM	Material Accounts
AB		AN	Unfunded Debt
AC	Current Assets	AP	Plant Accounts
AD		AR	Reserves
AE	Equipment Accounts	AS	Surplus
AF	Funded Debt	AT	Capital Stock
AG		AV	Investments
AH		AW	
AJ		AX	
AK		AY	Prepayments
AL		AZ	

After these main subdivisions of accounts have been made, actual accounts may be symbolized by further subdividing these divisions mnemonically,

ITEM CLASSIFIED	DATA FOR CHARGING OF EXPENSES
A—GENERAL ACCOUNTS	
B—BUSINESS DIVISION	General Expense ←
C—SELLING DIVISION	Selling Expense ←
D—MANUFACTURING DIVISION	Shop Expense ←
E—ENGINEERING DIVISION *	Engineering Expense ←
	If both questions are answered NO then the charge must be against DEPARTMENTS
F G H J K L M N P R } PRODUCTS	**1ST QUESTION** ← Begin Reading Is the expenditure one involving work on product to be sold? NO→ ←YES Worked Materials or Product which will ultimately be sold to Customers
S—STORES	
T V W } PRODUCTS	
X—FIXTURES, TOOLS Y—MACHINERY, MOTIVE POWER Z—BUILDINGS	**2ND QUESTION** Does the expenditure increase the permanent value of the Plant? + 0 < YES)————(NO→

* If main division; otherwise under manufacturing.

+Partly charged to asset accounts and partly to shop expenses.

0 Construction or addition to equipment which wholly increases permanent value of assets.

BASE SHEET FOR MNEMONIC CLASSIFICATION

FIG. 52

or by merely adding account numbers after the two-letter symbol. Inasmuch as mnemonic symbols are less utilized for purposes of designating accounts than for any other purpose, no further examples will be given.

Organization nomenclature. The following method of building up mnemonic symbols may be used in designating the various portions of the organization which have been classified. The nomenclature thus developed indicates immediately the relation of each unit of the organization to the organization as a whole. It is useful from that standpoint in the day-by-day operations of the business, as well as for expense division and distribution.

B—Business Division

BA	Accounting Department	BM	
BB		BN	
BC	Comptroller's Office	BP	Personnel Division
BD	Auditing Section	BR	
BE		BS	
BF	Office Manager	BT	Cost Accounting Section
BG		BV	Miscellaneous Business
BH	Cashier	BW	
BJ		BX	Executive Department
BK		BY	
BL	Sales Order Department	BZ	

Office Manager's Group

BFA		BFM	Mailing Unit
BFB		BFN	Messenger Service
BFC		BFP	
BFD		BFR	
BFE		BFS	Stenographic Service
BFF	Filing Unit	BFT	Telephone Service
BFG		BFV	
BFH		BFW	
BFJ		BFX	
BFK		BFY	
BFL	Library	BFZ	

C—Sales Division

CA	Advertising Section	CM	
CB	Branch House Department	CN	
CC	Customer's Service Department	CP	Promotion Department
CD		CR	
CE	Executive Office	CS	Sales Managers' Department
CF	Foreign Sales Department	CT	
CG		CV	
CH		CW	
CJ		CX	
CK		CY	
CL		CZ	

CA—Advertising Section

CAA	Advertising Manager's Office	CAM	Domestic Magazine Unit
CAB		CAN	Domestic Newspaper Unit
CAC		CAP	
CAD		CAR	
CAE		CAS	
CAF	Foreign Advertising Unit	CAT	
CAG		CAV	
CAH		CAW	
CAJ		CAX	
CAK		CAY	
CAL		CAZ	

D—Manufacturing Division

DA	Auxiliary Departments	DM	Milling Department
DB	Blacksmith Shop	DN	Foundry
DC		DP	Punch Press Department
DD	Die-making Department	DR	
DE	Experimental Department	DS	Screw Machine Department
DF	Final Assembly Department	DT	Tool-making Department
DG	Grinding Department	DV	
DH	Polishing Department	DW	Wrapping Department
DJ		DX	
DK	Key-making Department	DY	
DL	Lacquer Room	DZ	Annealing Department

DA—Auxiliary Departments

DAA	Production Manager's Office	DAM	Maintenance Department
DAB		DAN	Inspection Department
DAC		DAP	Planning Department
DAD		DAR	Power House
DAE	Methods Department	DAS	Stores Department
DAF		DAT	Tool Department
DAG		DAV	Miscellaneous Shops
DAH		DAW	
DAJ		DAX	
DAK		DAY	
DAL		DAZ	

DAM—Maintenance Department

DAMA		DAMM	Blacksmith Shop
DAMB	Maintenance Department Office (Business)	DAMN	
		DAMP	
DAMC		DAMR	
DAMD		DAMS	
DAME	Electric Shop	DAMT	Truck shop—Motor—Teams
DAMF		DAMV	
DAMG		DAMW	
DAMH		DAMX	Maintenance Department Executive Office
DAMJ	Janitor Service		
DAMK	Construction Shop	DAMY	
DAML		DAMZ	

Expense nomenclature. Expenses incurred may be designated by the use of one of the following symbols, placed after the symbol of the department, division, or shop responsible for the expense. If there be fear of confusing the expense symbol with a designation for the subdivision of a department, zeros may be inserted, and the expense symbol thus always appear in the fourth, or other predetermined position. Example: BFOA-Salaries, Office Manager's office.

A	Salaries, Commissions and Wages	M	Machinery Repairs and Maintenance
B		N	Retainer—(Premiums, Bonuses)
C	Consulting (including Legal)	P	Power Transmission
D	Idle Machine Time	R	Reclamation of Error
E	Entertaining	S	Supplies—other than tools
F	Freight, Express and Cartage	T	Tools
G	Postage	V	Miscellaneous—not provided for
H		W	
J		X	
K	Trucking Internal—Transportation	Y	Traveling
L	Telephone and Telegraph	Z	Building Maintenance

Where further subdivision of these expense charges would be desirable, this might be best accomplished by numerical subdivision before the letter designating the expense, as:

1A	Salaries, executives	5A	Janitor Service
2A	Salaries, clerical	6A	Material Handling Labor Cost
3A	Commissions	7A	Crane Operator Labor Cost
4A	Miscellaneous Labor Cost		Etc.

Thus, clerical salaries for the planning department would be segregated under the symbol DAP2A, and janitor service for the whole shop would be DOO5A.

Product and worked material nomenclature. The nomenclature of product and worked materials under this scheme is provided for by symbols beginning with the letters F to W inclusive, with the exception of S. Thus, in a plant manufacturing miscellaneous types of locks, the product classification might be as follows:

F		N	Night Latches
G		P	Padlocks
H		R	
J		T	
K		V	
L		W	
M	Combination Locks		

In many cases where a plant manufactures one composite product, such as an automobile, it is desirable to treat that product as two or more distinct things, such as chassis and body. The important point about setting up a workable product classification is to visualize every group which goes into the final assembly. These groups are then broken up into divisions, sections, and subsections.

To illustrate the methods of classifying and symbolizing these groups and sections it is advisable to follow through the construction of nomenclature for one of the products enumerated above. Selecting padlocks, it is first ascertained that there are various kinds of padlocks, as follows:

PA		PM	
PB	Bronze Padlocks	PN	Non-pickable Padlocks
PC	Cast Brass Padlocks	PP	
PD		PR	Railroad Switch Padlocks
PE		PS	Steel Padlocks (Except PH)
PF		PT	
PG		PV	
PH	Heavy Duty Padlocks	PW	
PJ		PX	
PK		PY	
PL	Self-locking Padlocks	PZ	

The final product symbol is thus seen to be actually represented by two letters rather than one.

Selecting heavy duty padlocks, it is found that these are manufactured by assembling, in final assembly, several subassemblies, as follows (see Fig. 53):

PHB	Back Assembly
PHD	Dog Assembly
PHL	Bolt Assembly
PHM	Miscellaneous Assembly (Separate parts going into final assembly)
PHT	Tumbler Assembly

The back group or assembly is composed of a number of parts, which, for convenience, may best be expressed as numerals, placed before the last letter. If the product were more complicated, and were composed of a number of subassembly sections, which were in turn assembled into the main subassembly, there might be four or five letters used, so that all these might be symbolized. In such a case, the components of the last subassembly would again be designated by numerals placed before the last letter. The back group may be designated as follows:

PH1B	Back	PH4B	Shackle Post
PH2B	Case Stud	PH5B	Dog Stud
PH3B	Bolt Spring Post	PH6B	Shackle Spring Post

Unless the purpose of developing such elaborate symbols is briefly considered at this point it may seem that they are unnecessarily complex. Each part which goes into the final product must be made, usually by performing several operations. It must be routed through the plant

Fig. 53.—A 2½-in. Heavy Duty Padlock. Finished lock (with front cut open), subassemblies and components entering into final assembly. (The symbols used are not those of the Miller Lock Company, manufacturers of the lock, this lock having been selected to illustrate mnemonic nomenclature and routing because of its extreme suitability.)

and assembled with other parts to become a portion or whole of the final product. As such it must be controlled, and to be controlled it must be designated in some manner, either by a name or by a symbol. Furthermore, all parts must be stored at times, and yet be readily available

when wanted. Some designation must be attached to each part, in order that it may be stored properly and designated in such a manner that it will be readily available or can be separately accounted for. The system of symbols being described, in addition to fulfilling all these requirements, readily shows the relationship of one part to another.

The worked material symbols can be arranged to show dimensions or size of the product, so that the different varieties of similar products may be distinguished. Thus, if the product be a $2\frac{1}{2}$-inch heavy duty padlock, the symbol becomes P $2\frac{1}{2}$ H. This size designation will be carried by every part going into the lock, as P $2\frac{1}{2}$ H1B, back for $2\frac{1}{2}$-inch heavy duty padlock.

The worked materials classification serves as a means of designating shop operations. This is accomplished by inserting the number of the operation, in the sequence which makes the piece, in front of the piece symbol. Thus 1P $2\frac{1}{2}$ H1B is the first operation in the manufacture of the back for the lock. The second operation in the final assembly would be 2P $2\frac{1}{2}$ H.

The worked materials symbol may be utilized also to show the lot number of any order in process. This may be accomplished by the addition of the lot number at the end of the product or worked material symbol. Thus P $2\frac{1}{2}$ H7 represents lot number 7 of $2\frac{1}{2}$-inch heavy duty padlocks.

From the foregoing it becomes apparent that there are certain rules of number utilization in mnemonic symbols which have been built up on the basis of long and hard experience. First, only operation symbols may be used as prefixes to worked material symbols. Second, care must be utilized in the insertion of dimension numbers between the last two places of a worked materials symbol lest these be confused with the part symbol. Third, numerical parts of the worked material symbol may not be placed after the last letter, as this place is reserved for lot numbers.

Stores or raw material nomenclature. It is in the classification of stores or *Purchased* Materials that the greatest possibility for variations in the methods of classifying is found. Because articles are bought from several manufacturers under different names, though the articles may be the same or similar, an additional difficulty is faced. Because of the choice of methods, and the possibility of ambiguities in the classification, it becomes essential that every detail be carefully guarded. Those articles, which are special rather than standard articles of stores, are not classified, but are given serial numbers prefixed by the letter " S." Thus, S1242 is an article carried in stores only temporarily, which is not a standard article of supply in the plant. This saves unnecessary work in classifying and at the same time an automatic signal is provided to prevent the article

from being carried too long. It will also help to indicate automatically when too many of a special article are on hand.

The two general methods of stores classification are:

1. Classification of materials by their nature.
2. Classification of materials by the use to which put or the purpose served.

The former permits a classification universal in its nature, and is probably necessary in very large, complex plants. When carried to its logical conclusion, it results in somewhat longer symbols than the second method. The second method may result in unnecessary duplication of symbols and some obscurity, but in plants making standard product it is altogether desirable.

In the first method, the first sheet of the stores classification would be somewhat as follows:

S—Stores (Purchased Materials)

SA	Stationery and office supplies	SP	Paper (other than stationery and printed forms)
SB		SR	Rubber and articles made chiefly therefrom
SC		SS	
SD	Dyestuffs	ST	Textiles
SE		SV	Various materials not otherwise classified
SF	Printed forms	SW	Wood and articles made chiefly therefrom
SG		SX	Tools and appliances
SH		SY	Repair parts for machinery
SJ		SZ	Fuels
SK			
SL	Liquids		
SM	Metals		
SN			

Under this method the further classification of stores results in a narrower definition of each type of material. Thus SMZ might stand for metal fasteners. That being the case, SMZB would be bolts and SMZBH hexagonal bolts. If made of various materials, such as wrought iron, cast steel, cold-drawn steel, etc., each variety might be distinguished by a number, so that SMZB1H might mean a wrought-iron bolt. The size of the bolt would be indicated by dimension numbers placed between two of the symbols (not between the last two), as SMZ $\frac{7}{8}$ 2B1H. This shows that the bolt is $\frac{7}{8}$ inch in diameter and 2 inches long.

In this type of stores classification it is frequently desirable to set up, as major divisions, some types of materials which are particularly important in the business. For instance, in a textile plant operating its own dyehouse an example would be found in dyestuffs, as indicated above. The

nomenclature for stores under this main division might be built up as follows:

SD—Dyes

SDA	Acid Dyes	SDM	Mordants
SDB	Basic Dyes	SDN	
SDC	Coupled Dyes	SDP	Naphthol Dyes
SDD	Developed Dyes	SDR	
SDE		SDS	Sulphur Dyes
SDF		SDT	
SDG		SDV	Vat Dyes
SDH		SDW	
SDJ		SDX	Oxidized Dyes
SDK		SDY	
SDL		SDZ	

SDA—Acid Dyes

SDAB	Acid Dyes, Blue	SDAR	Acid Dyes, Red
SDAG	Acid Dyes, Green	SDAV	Acid Dyes, Violet
SDAL	Acid Dyes, Black	SDAW	Acid Dyes, Brown
SDAN	Acid Dyes, Orange	SDAY	Acid Dyes, Yellow

SDAB—Acid Dyes, Blue

SDA1B	Acid Peacock Blue	SDA3B	Alizarine Sapphire
SDA2B	Alizarine Blue	etc.	

In the second method of stores classification the first sheet will have the materials grouped mainly with reference to the products on which they are used. Such classification is particularly valuable in plants manufacturing standard products, or in plants where a large proportion of the stores are intended when purchased, for use on one particular product. To illustrate:

SF		SN	Stores for night latches
SG		SP	Stores for padlocks
SH		SR	
SJ		ST	
SK		SV	Stores used for a variety of purposes
SL			
SM	Stores for combination locks	SW	

By this method the stores which are used exclusively on one of the products are classified by the same general symbol as the product itself, with the prefix S. Using the same illustration as that which was used to develop the worked materials nomenclature, it is found that the shackle

post for a heavy duty padlock is designated as SPH4B if the piece be purchased rather than manufactured. If the piece be made in the shop and then put in the storeroom, its worked material symbol would be PH4B. This illustrates the most valuable advantage of this method of stores classification. Under it, the symbol for stores and worked materials vary only by the prefix of the letter S, provided that the part is used exclusively on one type of product.

The stores used for a variety of purposes must necessarily be classified by nature, rather than by the use to which they are put. The skeleton nomenclature for such stores would be therefore as follows:

SVA Miscellaneous stores, not otherwise classified
SVB Brass and articles made chiefly therefrom
SVC Cast iron
SVL Liquids
SVT Textiles
etc.

Mnemonic nomenclature of tools. Tools are classified in much the same manner as stores. The prefix X is usually retained in any accounts dealing with tools, as indicated in the master sheet. This prefix is ordinarily dropped when stamping the symbol on the tool or referring to the tool for shop purposes. For a metal shop, which has most need of an elaborate tool classification, the following is an effective base sheet:

XA Miscellaneous Tools for special purposes not elsewhere classified.
XB Abrading Tools—All tools for filing, grinding, polishing, rubbing, scratching, scraping, lapping, etc.
XC Clamps and Holding Devices—Clamps and holding devices of all kinds including bolts and screws, except J & N.
XD Drilling and Reaming Tools—Tools which remove material from the interior and produce the required size through the nature of the tool itself, *e.g.*, boring bars, boring cutters, drills.
XE
XF Forming and Bending Tools—Tools which change the shape without removing the material.
XG
XH Heating Tools—Heating, lighting, melting, molding, oil tempering, annealing, drying, except such as are classified under C and N.
XJ Jigs and Fixtures—Holding devices for specific purposes in connection with the product worked upon. Designed for manufacture of duplicate parts of a given product.
XK
XL Milling Tools—Tools which remove materials from the surface by means of the revolution of the tool, and produce the required shape through the nature of the tool itself.
XM Measuring Tools—All gauges and instruments of precision.

XN Containers—Containers for holding materials, except as classified under C, J, or T.
XP Paring Tools—All tools which remove material from the surface by means of stationary tools and produce the required size through the operation of the machine, excepting L.
XR Slitting Tools—Used for dividing material into parts.
XS Striking Tools—Hammers, and all tools that work by striking or being struck.
XT Transportation Tools—All tools used in moving material.
XV Miscellaneous Tools, except N and C.
XW Wrenches, and all tools for causing rotation.
XX
XY All mechanical devices used in office work.
XZ Patterns.

P—Paring Tools

PC Parting Tools	PS Square-nose Tools
PR Round-nose Tools	PT Thread Tools

PR—Round-Nose Paring Tools

PRB Blunt Round-nose Tools
PRS Sharp Round-nose Tools

PRB—Blunt Round-Nose Tools

PRBL Blunt Round-nose Tools, Left-hand Bent
PRBR Blunt Round-nose Tools, Right-hand Bent

Mnemonic nomenclature of machinery. Machinery, like tools, usually retains the main classification letter (Y) when its symbol is used to express an account, but drops it when used for shop purposes. Machinery may be classified either by the use to which it is put, or by trade name. A portion of the subdivisions, if classification be by use to which machinery is put, might be as follows:

YB—Abrading Machinery—Removes material from surface by abrasion.
YE—Energy-transforming Equipment—Changes energy from one form to another without the intervention of a machine, e.g., boilers and transformers.
YK—Revolving Cutting Machinery—Removes material by a revolving motion, either in the tool or material, e.g., lathes, boring mills.

If the classification be by trade name, which is more common, some subdivisions might be:

YB Boring Mills	YP Presses
YG Grinders	YT Tumblers
YL Lathes	YV Production centers which do not include machines

L—Lathes

LA Automatics	LL Low-swing Lathes
LE Engine Lathes	LT Threading Lathes
LH Hand-feed Turret Lathes	etc.

If there be a number of machines of the same type in the shop, each is designated by placing a number after the machine symbol, as LE7, engine lathe number 7.

Mnemonic nomenclature of buildings. Buildings may be readily classified and symbolized in some such manner as the following:

ZC Conveying Devices	ZP Underground Piping and Tunnels
ZE Building Equipment	ZR Power-house Structures
ZF Office Space	ZT Transmission Lines
ZM Manufacturing Space	

Summary of mnemonic nomenclature. Although any portion of the mnemonic scheme of nomenclature can be used separately, and although it may be adapted in any desirable way, or used in conjunction with numerical nomenclature, it has been discussed above as a complete system. As such it completely fulfills the objects that were established for standard nomenclature. In the first place, it gives a measure for the definiteness of functions because by it the duties of individuals can be definitely codified, be they executive, clerical, or manual; secondly, it provides a definiteness and correct sequence of operations by the use of the product classification in conjunction with proper routing and despatching methods; thirdly by means of the stores and product classifications, it provides for locating materials, both in the storeroom and in process, and makes easier the task of keeping a perpetual inventory of these articles because of the elimination of much writing of names that would be necessary if there were no symbols; fourthly, costs are more readily obtained.

From the master sheet of the classification (Fig. 52) it has been seen how these primary elements are provided for and how, by the elaboration of the various groups, every item of expenditure is given a symbol. With the correct use of these symbols, the allocation of costs is made comparatively easy. It is not the purpose here to illustrate this point, because a more detailed knowledge of the functions and operation of the production department is needed to fully comprehend the true relation between classification and costs. Finally, the system serves as an automatic index for the filing of all "inside shop" information. If information about an operation is to be filed, it is filed by the operation symbol. The same is true of machine specifications and records, product information, cost records of products, and all other matters pertaining to shop routine.

It was pointed out that the functions of individuals were classified. Thus information regarding the individual or his functions can be filed by those same symbols which designate the main classes. Stores records are filed by the stores symbols. Time study data and blue-prints are filed by the symbol of the product to which they apply.

PART V

JOB STUDY

CHAPTER XVIII

PRELIMINARY JOB-STUDY CONSIDERATIONS

The need for job studies. Many manufacturers have permitted, and some still permit, line supervisors, such as foremen, with a multitude of duties to perform, to set job standards. Sometimes this task has even been left to the workmen. Management has frequently been content to allow these men to ascertain and retain this information, and has not thought it worth while to gather it together, correlate or classify it, or better the methods which have been utilized in performing the work. Amid these general conditions the idea of job study has been gradually developing for some years until it has now proved itself and has been generally adopted, at least in its fundamentals, by forward-looking plants. They have decided that it is not really easier, in the long run, to guess than it is to know, and have decided that intelligent job study brings with it invaluable data which they need in daily operations. Gradually, industry has turned to methods which have substituted exact knowledge, as gained by job study, for guesswork, and careful analysis for the somewhat intangible standards based wholly on experience. The correlated and classified information gained through job study is now being used as stepping stones to better methods of turning out jobs, the best method if possible.

Lack of knowledge of what should constitute a job and how long it should take is one of the basic causes of labor disputes and industrial unrest. Since neither the employer nor the employee has any real information concerning these phases of the job, or concerning a single job in relation to other jobs, arbitrary standards are frequently set up by both sides which are widely divergent in order that they may be safe for both. An attempt of either side to enforce the basis that it has arbitrarily set up results in dispute, which is usually settled by a compromise not predi-

cated on facts, and which is satisfactory to neither party. Just as lack of job standards is one of the most frequent fundamental causes of industrial disputes, plants which have carefully set job standards are ordinarily those in which there are the fewest disputes and in which such disputes as do arise are settled most promptly and amicably. There is a basis of exact knowledge on which to settle them, and facts are used in these plants rather than opinions, prejudice, connivance, or force, which have been the more usual bases of settlement.

Only the surface of the limitless possibilities of job study has been scratched by industry. The gold mine has been found and it has tested true, but it has not been extensively worked. Plant after plant has failed to make advances in this, one of the most important phases of modern management. It may almost be said that industry after industry has failed to take advantage of the opportunities which it offers. Its constructive benefits, which cause improvements in every phase of the business, lie as an unopened book to large portions of the industrial community. Other portions of this community, while sensing the efficacy of the information gathered through job study, have endeavored to utilize it as a weapon of offense rather than as a basis for amicable agreement.

The purposes of job study. The purposes of job study are two, the first of which may be utilized independently, without any thought of the second. These are, to improve methods and conditions of work, and to develop a basis for the setting of rates. Methods are improved through a study of the operation and then, from the findings of the study, the equipment furnished workers is changed and the new methods are taught them.

Anyone at all familiar with industry knows that, on most jobs, different operators, if left to themselves, will do their tasks in entirely different lengths of time. Differences of 100 per cent in the time that it takes two operators to do the same task are not at all unusual. In one textile plant, it was found that certain weavers were earning up to $60 a week on the same tasks on which other workers were only earning $15, work being on a straight piece-rate basis. Upon inquiry, it was found that the foreman felt that the reason for the discrepancy between such groups of workers was that they were "born that way." It will usually be found, after study, that such operators are utilizing entirely different methods to perform the job. If the two workers be analyzed, it will be found that one has discovered a number of short cuts, while the other is performing a large number of useless or cumbersome motions. It is thus seen that the first step in job study is to determine the way in which the best worker performs the job, in order that some of these methods may be imparted to the poorer workers. The next step is to endeavor to develop a standard method, which may be an improvement over the best

method used to that time, and which will not only improve all existing methods of working, but will include the utilization of all possible standard equipment for the job and which will determine and, if possible, eliminate, the causes of fatigue incident to the job.

Motion study. Motion study is the simplest form of job study, and always forms the preliminary portion of a job study, even if a more elaborate study, such as a time study, is contemplated.

The simple motion study of a job in its general elements may reveal many losses and useless motion without any consideration of the time element. It is not necessary to hold a watch in one's hand to know that a worker who must walk a dozen feet to secure material for his machine or to deposit the finished product of his operation can have his work arranged more effectively. Sitting down beside the workman over a period of several hours and following what he does in a general rough way will yield valuable information concerning sources of losses of this nature. Then in the study of the specific details of the job as the workman works upon it, the study of the "swing" or rhythm which the workman gets into his body on repetitive work can be made without regard to the time element. General motion study is likely to yield valuable information for the betterment of standards of equipment, and the elimination of useless motions is oftentimes one of the best ways of reducing fatigue. So all the aims of job study may be achieved without consideration of the time element, although if it is desired to refine these results, time study is usually utilized.

Interest in job study had been gradually increasing for a number of years, when certain experiments of Mr. Frank B. Gilbreth, in bricklaying methods, set forth in a small book called "Motion Study,"[1] crystallized interest in this subject. This was at about the time of the general increase in interest in the management movement, during 1911. Mr. Gilbreth's attention had been forcibly drawn to wasteful operation methods in this trade through his then connection with the contracting business. He had found, for instance, that bricks were dumped in a pile somewhere near the bricklayer by his unskilled assistant, and that the bricklayer would take two or three steps over to the pile of bricks, pick up a brick, walk back to the point in the wall where he was going to put it into position, give it several twirls, so that the right side for laying would be upward, and then proceed to put it into place. He also found that there were a large number of similar waste motions in connection with the placing of the mortar. From these observations he developed certain standard equipment, such as a packet for holding the bricks at a proper level and with the right side already up, and a non-stooping scaffold, which changed

[1] D. Van Nostrand Co., New York.

in height as the wall was built up. He then developed the best methods of utilizing this equipment, based on observation.

As the methods used by bricklayers on nearly every construction job are observed to-day it will be quickly noticed that the studies of Mr. Gilbreth and others have not made the impression on this ancient art that might have been expected. This condition is sometimes due to the contractors, but in general it is caused by the attitude of the bricklaying unions to the studies of Mr. Gilbreth. As in the case of other labor organizations, they have not been favorable to the developments brought about by job studies, and they have been strong enough to successfully resist the introduction of much of the new method. A full discussion of the reasons behind this attitude will be included later.

One of the next fields that was investigated, after Mr. Gilbreth directed attention to the wastes involved in ordinary bricklaying practice, was office work. In the handling of outgoing mail it was immediately seen that there were vast opportunities for economies in an improvement of the methods generally used in large offices. If several thousand letters are being mailed a day, as is the case in many industries, the saving of only one motion per letter mailed would result in an enormous net gain. For instance, in one office the girls folding and sealing the letters formerly were permitted to arrange the work to suit themselves. A short observation of their work showed that there was much room for improvement. Experiments were made to determine in just what order each movement should be made to fold the letter, pick up its inclosure, pick up the envelope and insert the letter and its inclosure in the envelope. First attempts were crude, but immediately doubled the output of the girl. Further study resulted in improvements which not only eliminated motions, but shortened the distance through which the hands had to move in those that remained. The final result was an arrangement of pieces and a sequence of motions by which each hand, at the completion of one motion, was in a position to immediately begin the next. The final motion, that of throwing the filled envelope on the pile, was eliminated entirely by having a large basket on the floor, directly under the point where the letter was inserted in the envelope. The girl simply let go of the envelope, and it fell into the basket, gravity doing the work formerly done by the girl. The output under the new conditions was about four times that obtained when the girls were allowed to do their work their own way.

Effects of taking motion studies. There are three possible changes which come through the taking of motion studies. First, whole methods of performing operations may be changed and newer and more effective ones found. Second, moderate changes in method and in equipment may be devised. Third, data are always secured from which a series of job specifications may be developed.

Motion study and the development of standard equipment are inseparately linked. Frequently, soon after the start of a study, it becomes apparent that the worker can do no better with the equipment at hand, because he is forced by it through a series of false motions. Motion study may lead to such standardization of equipment on an operation that no further steps are needed in the instruction of workers in the performance of their jobs than instruction in proper use of this equipment. In changing the methods used on the operation, changes are always made in the direction of straighter, shorter, quicker motions of a kind which tend to swing into the following motion, and which become automatic wherever possible. Particular information for job specifications is secured concerning the dexterity, strength, and temperament required of the worker, as well as any unusual requirements which are peculiar to the job.

Meaning of time study. By time study is meant an accurate analysis of the time necessary to perform a task or some part thereof. It involves all the features of close observation that are found in motion study, and in addition there is included the time element. In modern industry, for purposes of job study all work may be placed under two general headings, (1) work done by machines and (2) work done by workmen. Motion study generally includes only a study of the work done by workmen, whereas time study includes a detailed analysis of both "machine time," or the time taken by the machine in doing its share of the work, and "handling time," or the time taken by the workman. Handling time will usually be found to be of three general classes, (1) the handling of tools used by the workman in connection with the job, (2) the handling of the machine by the workman, and (3) the handling of the material that is being worked upon. Time study implies an intense analysis of all these phases of work.

Purposes of taking time studies. The purposes of making such an intense analysis of work are in some respects not dissimilar from the reasons behind the making of any job studies. Improvement of methods and conditions are at times the only reasons for the making of time studies. Indeed motion studies are frequently but the first step in the taking of time studies and pure motion studies are not so frequently used as time studies, since with but a slight additional cost the additional valuable data securable through time studies may be made available. The addition of the time element to the study makes it possible to secure information concerning the amount of work which may be accomplished within a given time. This information gives an adequate basis for establishing the remuneration to be given a worker for his performance. Thus, the results of time studies are used as the basis of "rate-setting," or the determination of wage rates. This is the second broad purpose for which time studies are used and the one which will be in the background of most

of what is here said concerning time studies. However, time studies cannot be used for rate-setting without being used at the same time to improve methods or conditions.

Time study provides data which are invaluable in setting rates that are relatively fair as compared one to another. It cannot be expected to set rates that are inherently fair from a cost-of-living or other similar standard. That is beyond its province. It does clearly indicate fair relative rates to be paid on the several jobs studied. It bases results upon facts rather than upon opinions, bargains, or past records.

Rates, if not based on time studies, are likely to be based on past performances. Standard time and, hence, rates, based on past performances, are likely to be unfair. In all factories are to be found poor workmen and good workmen. A good workman on job A takes an interest in his work and in the mastering of his job. A poor workman on job B is probably indifferent to his work, or it may be that he has never been properly instructed as to the right way of working on the job. If the records of poor workmen and good workmen are thrown together, throughout a shop, as "past performance," the resulting basis of rate-setting is likely to be unfair. The poor workman, by learning his job or merely by applying himself, may be able, under such conditions, to double his pay, whereas the good workman, if the job is one where he has always set a high standard, will get but a slight wage increase, if any. In other words, the poor workman will be rewarded for his indifference of the past, and the good workman will be penalized for his past attention to duty. Other difficulties in setting rates on the basis of past performance are due to the fact that past records are frequently extremely unreliable. Jobs of the past frequently were made up of different elements than jobs of the present. Conditions under which jobs were performed often have been modified by forgotten changes in equipment which are not taken into consideration as the new rate is set. Frequently, since the past records are so unreliable, it is necessary to resort to bargaining concerning what past performance was. Nothing can be more destructive of the wage fabric of any plant.

Steps in taking time studies. To secure accurate knowledge of the time that is necessary to perform a certain job is by no means in itself a simple task, and the taking of the time is but one portion of the whole task of taking a time study. Time studies, to be of any value, must be "elementary time studies." That is, the time must not be taken for the job as a whole, but for the various elements of the job, and then the correct time for the complete job determined upon after making an analysis of the times necessary to do the various elements. In the job of operating any machine there will be found a long series of elements, ranging from those involved in starting the machine and placing material

in it, through those involved in turning certain controls during the operation of the machine to those involved in removing the work from the machine. The taking of the times, when the job is split into such a large number of small elements, is a rather skilled task.

In taking time studies there is entailed (after standardization work has been completed) first, a careful survey of the task to be done, with a view to improvements in method of the kind referred to in the discussion of motion study. These improvements are then made, or are made in conjunction with the second step, namely, the division of the task into its elements. The third step is the "taking of the times," or observation and record of the time consumed in each of the elements of the job; the fourth, a study by analysis of the records obtained; and the fifth, the fixing of the proper operation time on the basis of these records.

The fourth and fifth steps involve considerable study, in determining the correct way to utilize the information which has been collected. In recording times for elementary operations it is usually found that there have been some abnormal readings, and these must be eliminated; allowances must be made for delays which may have occurred, or which may occur in the future, and these delays must be considered in the light of their being avoidable or unavoidable. There must usually also be some allowance made for fatigue on the part of the operator. Frequently, on the basis of the data, the whole job is rearranged and restudied.

The job-study observer. The first requisite in job study is that the observer be competent. This is so outstandingly true that it would be ridiculous to mention, were it not that incompetent managers frequently use incompetent time-study observers, and otherwise competent managers have frequently seemed to feel that anyone, equipped with a stop-watch, could secure the necessary information. It is for this probably more than any other reason that job study fell into disrepute among many portions of the industrial community. The observer must be of an analytical turn of mind, able to detect small variations in the process from time to time. Thus, one executive states that, in his experience, chemists have made the best job-study men, because of their training in analysis. The observer must not only be skilled in the art of making time studies, but he must be fully conversant with the type of work which is being observed, although it is not necessary that he himself be a skilled worker on the particular task. He must, however, have enough knowledge of the machine and process to be able to perceive and try out slight mechanical changes which may be called to his attention during his studies.

Besides these technical qualifications, a job-study observer must be able to win the confidence of the men with whom he is working. This means he must himself have confidence in the workers and gain their confidence, as well as gaining the confidence of the superintendent and the

foremen. This implies that the observer must have an outstanding personality which will cause the workers to want to aid him in his experiments, rather than resist his efforts to change their job. If the observer creates the impression that the worker himself is making all the suggestions it is probable that his full co-operation will be secured. In devising a standard method to perform a job, many possibilities will have to be investigated, and the worker's co-operation is essential, particularly if he has a fund of knowledge based on past experience with the task. The co-operation of the worker is essential in order that correct results may be secured from the study.

Regardless of how high the authority for the beginning of the studies may be, co-operation of the superintendent and foreman is necessary in order that the results may be actually utilized. If the superintendent feels that "there's not going to be much value from the studies," the foremen, who usually take their cue from him to an extent almost unknown in any other walk of life, are also sure that there is no good in the study before it starts. Most superintendents can be shown the value of the studies on the basis of increased production at reduced cost. If the superintendent does not approve of the work it may be well to postpone it until his co-operation can be secured. Respect for the foreman's authority must be the keynote of the observer's relation to him. If orders are given through him but little difficulty may be expected, providing that the observer's attitude is that he is merely adding to the foreman's knowledge, not that he is replacing it. Although, in fact, but few foremen have made close personal studies of all jobs within their department, most foremen seem to feel that it is expected they should have such knowledge. The observer has an excellent opportunity to win complete confidence or lose the confidence of the foreman entirely by the way he treats the foreman's prior knowledge of the job.

There is no intention to minimize the necessity of technical qualifications of time-study observers, because the more the observer knows of the operation, the better able he will be to suggest alternative methods. On the other hand, if he has gained the confidence of the whole department in which he is working, he has performed a large portion of his task. Some firms have tried to take time studies with the observer nonchalantly observing the worker with a stop-watch in his pocket, or probably two or three of them in different pockets. Other concerns have utilized balconies in the shops to take time studies without the worker's knowledge, and then have wondered why the workmen made objection to approving them as a wage basis when suddenly apprised of the "results." Confidence, as the prime element of success in time-study work, cannot be overemphasized.

Confidence is necessary for several reasons. (1) As in any manage-

ment step, full co-operation of everyone is needed for the best results. (2) Secrecy is impossible even should it otherwise be desirable. The workmen will hear rumors, which will be worse than the facts, whatever they may be, and these rumors will be confirmed when their rates are changed based on the observations that they knew only rumor of. (3) In order that the time study may be of maximum value, it is necessary that all the shop information, which has been collected by the foreman and workmen over a period of years, shall be at the disposal of the time-study men.

The operator to be studied. To this point nothing has been said of the caliber of the operator who should be studied. That is, should the operator be the best man who is available, should he be a first-class man, should he be an average workman, or should he be picked indiscriminately from the shop? It will be noted that this question may have to be answered differently in the case of time study from the way that it is answered in the case of motion study. In the latter case, the study is being made purely from the standpoint of method, whereas with time study the study is also usually to be used for the purpose of setting rates. Time-study men generally incline to the belief that it is the skilled, first-class worker who should be studied. This means that the worker will be of better than average ability, and will be as good on quality as he is on quantity. This does not mean that the study will be made on a man who is working at a terrific rate of speed, for such a man probably is turning out no more production than the man who, more skilled, is taking things easier.

The skilled man is selected, rather than the average man, because allowances will be made in the computation of times which will be fair to the average man and the skilled man is better for observation purposes. His motions are uniform, he works steadily, he is apt to use the best methods and adapt himself more readily to new ones. The erratic work of unskilled employees would throw all sorts of variables into the calculations which would merely have to be ruled out as the computations were made. The experienced time-study observer, acquainted with the character of the work, soon learns when a skilled operator is doing his best. He would have more difficulty in finding this out in the case of an unskilled operator. The observer, with the skilled man, is able to get him to better his production if need be, or, on the other hand, to recognize unusual ability or excessively rapid movements on the part of the operator which could not be maintained without physical exhaustion. Such cases are properly discounted by him, for the desired task time is one that can be used by workers following instructions and working at a reasonable pace—a pace that can be kept up from day to day without undue exertion. Another reason for the selection of the skilled man is that in setting performance

standards, as in setting any other standards, the best known at the time for the given conditions should be selected as the standard.

The conditions of the observation will have to be varied somewhat in the case of "group work," that is, work in which the individual task is performed by more than one employee. In such work as assembling, the speed of the group is limited largely by the speed of the slowest member. Therefore, in such cases, it will be necessary to carefully consider the personnel of the group to see whether or not it is entirely composed of skilled employees, and, if not, whether such a group can be brought together. There are two classes of group work, and the necessary skill of all members of the group will vary with the class into which the particular work falls. These classes are, (1) where the main part of the operation is performed by one employee, and he is merely assisted by other employees, and (2) where several employees work together, each doing his portion of the job in proper sequence.

An illustration of the first type of group work is to be found in the operation of laying cloth in a clothing factory. Although the operation is comparatively simple, it demands a certain knowledge of the tailoring trade and the peculiarities of cloth, to handle each type properly. A cloth which has a very smooth finish may be easily disarranged in pulling one layer over the next, while another which has a heavy nap may tend to stick and must be handled in an entirely different manner. One employee cannot do the work alone because of the width of the cloth, which requires that he have an assistant working on the opposite side of the table. The assistant, of course, must learn how to handle the cloth, but he does not need as much detailed knowledge, and hence will not need to be as skilled an employee as the one in charge of the operation. As an example of the second type of group operation may be taken any case of continuous assembly, where the speed of one worker is limited by the speed of another, and yet all of them are doing work of approximately equal importance.

Dangers to be guarded against in taking job studies. Though the possibilities for good of job study, properly used, are almost unlimited, when incorrectly used its possibilities for evil are the same. Job-study methods must be guarded as would be high-voltage electric wires or T.N.T. If it is carelessly used, the results will be shock or explosion fully equal to those following careless use of either of these. The first danger to be guarded against is an approach to a workman based on superiority rather than on science. There is a great tendency, particularly if the observer be inexperienced, to tell a workman who has the experience of years behind him that he is all wrong. Every possible safeguard must be developed to prevent such interpretation of the attitude of the observer. The worker may have been all wrong in such a case,

but so was the observer. The second danger to be guarded against is the taking of time studies when the conditions are not standard. Not only will all the work done be useless under such conditions, but the studies themselves will fall into disrepute. This is particularly true if the workmen knew of the loopholes in the standards being set at the time the studies were taken. They then will be in an excellent position to hide their smiles and criticize unmercifully. Time spent on the development of preliminary standards of material and equipment will pay profits much more promptly than twice as much time spent on standard times for unstandardized jobs. This "standard" time will be worthless, being based on variables. A third danger is to spend time in making "stunt" time studies. There is always a tendency to spend effort in reducing the times of performance on operations which are palpably poorly carried on. In such cases statistics of percentages of time reduction will be very interesting, but if the operation be an unimportant one, as it may very probably be if such huge reductions in performance time are possible, the profit from the study will be small. A series of such studies may cost more than the resultant profits, and a whole job-study programme thus fall into disrepute. The neck-of-the-bottle operations, the most important in any plant, should be studied first. Even small results achieved there will bring large profits with them, without question. It may take longer to get results, but if the continuation of a job-study program is based on quick results, the programme should never be undertaken.

CHAPTER XIX

TAKING AND COMPUTING TIME STUDIES

Time-study equipment. The equipment for taking time studies is essentially simple, though some improvements which are now being tried out will be described. The ordinary equipment consists of a decimal stop-watch, an observation sheet on which the watch readings are recorded as the study progresses, and a board for holding the watch and observation sheet. Many different forms of observation sheets have been devised. The attached sheet, (Fig. 54) used by the Corona Typewriter Company, of Groton, N.Y., will be used as the basis for this discussion of making time studies. It is selected because of its completeness and the care which that company observes in making and utilizing time-studies. In any event, the observation sheet must have space for a full description of the operation and conditions under which it was taken, with the latter illustrated, if practicable; space for entering the times of the various elements as they are observed; and a series of columns concerning the time of each element and the proper time for the whole operation.

The usual stop-watch used in time-study work is a non-continuous-movement watch; that is, the movement of the watch runs only when the large hand is in motion. The large hand may be started and stopped by pressing a slide on the side. This arrangement allows the watch to be started and stopped at will, without throwing the hand back to zero. Pressure on the top of the stem throws the hand back to zero so that the observer can commence the record of a new operation at zero if he should so desire. The dial of the watch is marked off into tenths and hundredths of a minute, instead of seconds and fractions of a second. This simplifies the recording and computing of times. This watch fits into a pocket near the top of the board carrying the observation sheet, and the board is of such a size as to be conveniently carried on the observer's left arm, so that the work, watch, and observation sheet may all be in a straight line with the observer's eye. The use of this equipment will be assumed throughout the following pages.

There are various special developments of the stop-watch methods of taking time studies. Some observers utilize as many as four different watches in taking one study, having specially rigged levers which throw them off or on as desired. By utilizing several watches these men feel

that they secure more accurate results, especially on short elements, because they can read the watch at their leisure, instead of taking a hurried reading in between elements of an operation. Mr. Frank B. Gilbreth has also utilized the motion-picture machine in taking time studies, by placing a special clock in the field of vision and recording thereby the times for the various operation elements. He has built up very satisfactory arguments for the utilization of this method where the elements are short and the work is on a standard product.

The preliminary study. The work of the time-study observer in what may be termed " the preliminary study " is, economically, in many ways more important than the actual recording of times themselves. From a wage-setting standpoint it is of paramount importance also, because it is frequently the work done here that determines the effectiveness of the final study. The " preliminary study " includes all of the work prior to recording the actual elementary times which are observed. It includes any purely motion-study work that is gone into in order that the operator may be working in the most effectual way, and it generally further includes some preliminary time studies for purposes of determining and recording the elements of the task to be timed.

Having determined upon the operator who will be timed, the observer should spend some time acquainting himself with the work and all conditions which are affecting it, or might affect it. He should observe the conditions under which the raw material is furnished the operator and the facilities which the operator has of disposing of the finished product. He should familiarize himself with the quality of the work demanded and the degree of accuracy required. He should see that the necessary equipment for the operator effectively to perform his task is provided and at hand, and if the operation is a machine one, he should see that there is a sufficient supply of power to drive the machinery to best advantage. Abnormal conditions should be remedied during this preliminary study. Full information should be secured concerning the standards of accomplishment on the job in the past, in order that comparative achievement records may be available after the job has been studied, changed, and timed.

Determining upon the elements. As indicated, preliminary time studies to determine upon the proper elements on suboperations in the job must be included in this early work. After selection, these elements are carefully recorded upon the observation sheet. An element of an operation may be described as a single continuous and distinct motion of a worker or a machine. Thus, in driving a screw, an element of an operation is performed in placing the screwdriver in the slot, if this is done as a continuous act; another element is performed in a continuous twist of the screwdriver in the screw. A more complex operation is necessarily

made up of a correspondingly greater number of elements, but each of them must be continuous and distinct.

The manner of separation of the operation into its elements is determined largely by the purpose of the study, the character of the shop, and the length of the elements. For instance, if the product be standard, not varying from day to day, and is made by repeating the same operation or set of operations, it probably will be wise to study the work from the standpoint of complete jobs, possibly lumping two or more of the minor elements together. Such time studies may be termed "operation time studies." The attached illustration from the Corona plant is an example of such studies. It will be noted that each suboperation in reality involves a combination of elements. This is the most common type of studies. If the product varies considerably, and is made by a series of operations, the elements of which may quite conceivably also be found in other operations on the same or similar products, it will be found extremely undesirable to lump any elements, for the time for each separate element may be desired in order that they may be regrouped to ascertain time for the other operations. Thus, by taking a series of time studies on a number of more or less fundamental operations and elements in a shop, it may be possible to arrange and combine data in such a manner that the proper time of performance may be secured for practically every job that the shop may perform, without the taking of new studies. Such time studies may be called "fundamental element time studies," and in these the time for each separate element is carefully secured.

In dividing the operation into its elements for the purpose of time study, it will usually be found that when the times of the individual elements are extremely small, it will be wise to group them and treat the combination as a single element. It is extremely unwise to try to observe and record elements which follow each other in successions of only a few hundredths of a minute, since an error in the reading of the time on the stop-watch may be as great or greater than the elapsed time for the element in question.

After the elements have been determined upon they are noted in the space provided for them on the observation sheet. In the accompanying example it will be found that there have been six elements studied:

1. Pick up, locate and lock.
2. Drill three No. 40 holes.
3. Drill five No. 48 holes.
4. Drill two No. 9 holes.
5. Unlock and remove.
6. Clean jig.

Preparing the observation sheet. Another important part of the preliminary work is to completely fill in all information called for in the

TIME STUDY OBSERVATION SHEET

CORONA TYPEWRITER CO., INC.

PART No. 2X92 OPERATION No. 4 OPERATION NAME DRILL ALL HOLES

OPERATORS No. 328 OPERATORS NAME H. T. FLYNN.

OPERATION PERFORMED IN DEPT No. 3 UNIT TIMED ONE JIG FULL, OF ONE PIECE.

OBSERVERS OPINION OF OPERATOR:— EXPERIENCE 5 MONTHS THIS JOB -3 YRS. DRILLING. SKILL HIGH GRADE AND RAPID. CO-OPERATION WITH OBSERVER EXCELLENT.

PURPOSE OF THIS STUDY:— FOR SETTING STANDARD TIME AND RATE YES. FOR PRELIMINARY SURVEY FOR BETTERING CONDITIONS — FOR TEST OF OPERATORS PRODUCING ABILITY —

SUB OPERATION NUMBER	SUB-OPERATION	UNIT TIMES RECORDED IN MINUTES AND HUNDREDTHS	AVERAGE TIME	MINIMUM TIME	TIME SHOULD TAKE
1	PICK UP, LOCATE AND LOCK.	R 11 12 10 10 11 11 12 10 10 10 10 11 09 11 10 12 11 11 11 10 10 10 11 09 10 11 11 12 09 09 10 09 09 10 08 09 10 10 10 11 10 11 09 09 10 11 10 11 10 10 T 11 12 10 10 11 11 12 10 10 10 10 11 09 11 10 12 11 11 11 10 10 10 11 09 10 11 11 12 09 09 10 09 09 10 08 09 10 10 10 11 10 11 09 09 10 11 10 11 10 09			
2	DRILL THREE #40 HOLES.	R 44 47 46 40 44 44 47 42 43 45 44 44 45 44 42 40 44 45 44 42 43 46 44 42 41 44 42 40 46 45 46 44 46 43 47 46 46 44 44 44 45 44 46 46 45 42 40 41 41 44 T 33 35 36 30 33 35 32 38 35 34 33 36 33 32 32 33 34 33 32 33 36 33 33 31 33 31 32 27 30 36 35 37 33 39 37 36 34 34 33 35 33 37 37 35 31 30 30 31 35			
3	DRILL FIVE #48 HOLES.	R 96 101 99 94 99 96 98 94 95 99 98 98 98 96 95 93 97 98 95 94 95 97 96 95 93 96 96 95 99 98 101 98 100 98 101 99 98 95 96 97 97 96 100 101 98 95 95 95 96 99 T 52 54 53 54 55 52 51 52 52 54 54 54 53 52 53 53 53 53 51 52 52 51 52 53 52 54 55 53 53 51 52 53 53 55 54 54 53 53 51 52 53 52 52 54 55 53 53 55 54 54 55			
4	DRILL TWO #9 HOLES.	R 111 115 116 109 113 110 114 110 111 115 115 114 116 112 111 100 114 115 113 111 113 111 110 107 111 110 111 114 112 115 114 116 114 117 116 114 112 112 113 114 113 117 114 115 111 111 110 114 T 15 14 10 15 14 14 16 16 16 16 17 16 17 16 14 17 17 17 18 17 16 16 15 15 14 15 14 16 15 14 15 16 16 16 16 17 16 17 16 16 17 17 17 18 17 16 16 16 15 15			
5	UNLOCK AND REMOVE.	R 116 121 121 116 118 116 120 115 119 121 121 121 122 119 106 119 120 118 117 116 119 118 117 113 117 116 116 120 118 121 120 123 122 120 117 118 120 121 119 125 126 122 117 117 118 116 120 T 05 06 06 07 05 06 06 05 08 07 06 07 07 07 08 06 05 05 05 06 05 06 07 07 06 06 06 05 06 06 05 06 06 07 07 06 06 08 07 07 06 06 07 06 06			
6	CLEAN JIG.	R 123 126 129 123 125 124 128 123 126 128 128 129 128 126 127 114 126 127 125 125 123 126 125 125 119 124 123 124 127 125 129 128 130 129 131 130 127 125 126 127 125 132 132 129 124 124 125 124 127 T 07 07 08 07 07 08 08 08 07 07 07 08 06 07 08 08 07 07 07 08 07 07 07 05 06 07 07 08 07 07 08 08 07 07 08 08 07 08 08 08 07 08 08 07 06 06 07 06 07 07 07 07 08 07			
	(CONTINUED)				
1	PICK UP, LOCATE AND LOCK.	R 10 10 11 11 11 12 10 11 09 11 10 10 10 10 10 12 11 11 10 10 12 11 09 10 11 10 11 09 09 11 10 11 10 10 10 09 08 10 09 09 10 09 09 12 11 11 10 09 10 11 10 T 10 10 11 11 11 12 10 11 09 11 10 10 10 10 12 11 11 10 10 12 11 09 10 11 10 11 09 09 11 10 11 10 10 10 09 08 10 09 09 10 09 09 12 11 11 10 09 10 11 10	1022	.08	.10
2	DRILL THREE #40 HOLES.	R 43 42 44 45 44 40 42 44 45 44 44 45 43 42 47 44 44 40 46 47 44 44 41 41 40 42 46 46 44 45 44 44 44 46 46 47 43 46 46 46 45 46 40 42 44 41 42 43 44 46 T 33 32 33 34 33 32 32 38 36 33 34 35 33 32 35 33 33 30 36 35 33 35 31 30 30 31 37 37 33 35 33 34 34 36 37 39 33 37 37 36 36 37 32 31 33 31 33 35 33 30	3382	.30	.33
3	DRILL FIVE #48 HOLES.	R 96 95 97 99 99 92 93 98 99 98 97 97 95 94 100 97 98 94 99 100 96 95 93 94 92 94 100 101 97 98 99 98 98 100 100 100 97 97 98 99 97 98 94 97 97 94 97 99 98 100 T 53 53 53 54 55 52 51 54 54 54 53 52 52 52 53 53 54 54 53 53 52 51 52 53 52 54 54 53 53 55 54 54 54 54 53 54 51 52 53 52 52 54 55 53 53 55 54 54 52	5312	.51	.53
4	DRILL TWO #9 HOLES.	R 110 111 115 114 106 107 114 115 114 113 114 111 111 116 113 115 111 116 118 113 111 108 109 106 109 114 117 112 112 113 114 114 116 116 117 113 114 114 115 114 115 111 115 114 110 113 115 113 115 T 14 15 14 16 15 14 14 16 16 16 16 17 16 17 16 16 17 17 17 18 17 14 15 15 14 15 14 16 15 14 14 16 16 16 16 16 16 17 16 16 17 17 17 18 17 16 16 16 15 15	1582	.14	.16
5	UNLOCK AND REMOVE.	R 115 116 117 120 119 112 113 119 123 120 119 121 118 118 124 119 120 116 121 124 118 116 114 115 113 114 120 123 117 120 119 120 121 123 123 125 119 119 119 120 120 120 116 123 121 117 119 121 120 121 T 05 06 06 07 05 06 06 05 08 06 06 07 07 07 08 06 05 05 05 06 05 05 06 06 07 05 06 06 05 08 06 06 07 07 07 08 06 05 05 05 06 05 05 08 07 07 06 06 07 07	062	.05	.06
6	CLEAN JIG.	R 120 122 124 129 127 120 123 126 129 127 126 129 126 121 131 126 127 123 129 131 125 123 121 123 119 120 127 129 125 129 129 128 129 132 130 132 127 127 128 127 129 124 130 129 124 126 127 126 129 T 05 06 07 07 08 08 09 07 06 07 06 08 08 08 07 07 07 07 08 07 07 07 08 06 06 07 06 08 09 10 08 08 09 07 07 07 08 08 08 07 09 08 07 08 07 07 06 06 05	073	.05	.07
	DELAY FACTORS.				
A	CHANGE DRILLS.	R 50 58 43 58 62 46 (2) 72 58 55 60 47 T 6.00 Min			
B	CLEAN MACHINE TABLE.	R 11 13 21 10 18 11 14 12 18 22 15 11 10 14 This time excessive, should be done while drilling T 2.00 Min			
C	ADJUST FLOW OF LUBRICANT.	R 19 26 10 T .50 Min			
D	CHANGE PANS OF WORK.	T None occurred during this study			

This is approximately 7% of the total time taken during study

NOTE—When possible record time for each sub-operation by continuous reading of watch, resetting to zero only at completion of each unit: Record elapsed time expended in each sub-operation in red ink. Observer must exercise extreme care in making studies for Production Tests or Standard Time and Rate setting purposes, to see that proper sequence of operations is maintained; that all unnecessary sub-operations or moves are eliminated; that proper appliances are provided, (including tools, in sufficient quantities) and that the proper and most economical combinations of speed and feed are used. In right hand column above, observer will give his opinion of the time that should be taken for each sub-operation by a fast and thoroughly experienced man, moving at his best normal speed. Observer will record a sufficient number of times to give a clear idea of the time required by the operator, for each sub-operation.

TOTAL AVERAGE 1264 1.13 1.25

H. V. Williams
OBSERVER

8/10/20
DATE

FIG. 54

To face page 242.

DETAIL RECORD OF METHOD OF OPERATION

SUB OPERATION NUMBER	FULL DESCRIPTION OF EACH SUB-OPERATION	MACHINE SPEED R.P.M.	MACHINE FEED P.M.	TOOLS USED IN EACH SUB-OPERATION TOOL NUMBER	TOOL — NAME
	OPERATOR WORKS SITTING DOWN.				
1	PICK UP ONE UNFINISHED PIECE FROM PAN ON TABLE, WITH LEFT HAND, PLACE IN JIG AND LOCK JIG.			590) 1125) 2347)	JIG
2	SLIDE JIG UNDER FIRST SPINDLE, DRILL TWO #40 HOLES IN TOP EDGE. TURN JIG ½ OVER, DRILL ONE #40 HOLE THROUGH SIDE.	2040	HD.	#40	DRILL
3	SLIDE JIG UNDER SECOND SPINDLE, DRILL TWO #48 HOLES THROUGH SIDE. TURN JIG ½ OVER, DRILL TWO #48 HOLES IN TOP EDGE. TURN JIG ½ OVER, DRILL ONE #48 HOLE IN BOTTOM EDGE	2040	HD.	#48	DRILL
4	TURN JIG ¼ OVER, SLIDE UNDER THIRD SPINDLE, DRILL TWO #9 HOLES.	2040	HD.	#9	DRILL
5	TURN JIG ¼ OVER, UNLOCK JIG, REMOVE FINISHED PIECE AND THROW IN PAN FOR FINISHED WORK ON TABLE.				
6	BLOW ALL CHIPS FROM JIG WITH COMPRESSED AIR.			AIR	VALVE

(NOTE - ALL SPINDLES ARE OPERATED WITH HAND LEVERS. KEEP A HEAVY FLOW OF LUBRICANT ON DRILLS. KEEP MACHINE TABLE FREE FROM CHIPS, SO JIG WILL SET SQUARELY. TEST DEPTH AND DIAMETER OF TWO HOLES AFTER EACH CHANGE OF #40 OR #48 DRILL.)

NOTE — Observer will be careful to give an exact record of all movements necessary to properly complete this piece. In operations where maintainance of an exact feed or speed is not of importance specify the allowable maximum and minimum limits.

STUDY TAKEN ON MACHINE-NAME 3 SPINDLE, STYLE E, LELAND GIFFORD CO. DRILL PRESS MACHINE NO. 040306

EQUIVALENT MACHINES ON WHICH JOB CAN BE RUN UNDER SIMILIAR CONDITIONS— NO. 040301-2-3-4-5, 040401-2-3-4.

EMERGENCY MACHINES ON WHICH JOB CAN BE RUN ANY OTHER DRILL PRESS (INCONVENIENT AND NOT DESIRABLE)

LOCATION OF UNFINISHED WORK IN PAN ON TABLE, LEFT OF OP.

LOCATION OF FINISHED WORK IN PAN ON TABLE, RIGHT OF OP

LOCATION OF FIXTURE OR SPECIAL DEVICES JIG ON MACHINE TABLE, FREE AND MOVABLE.

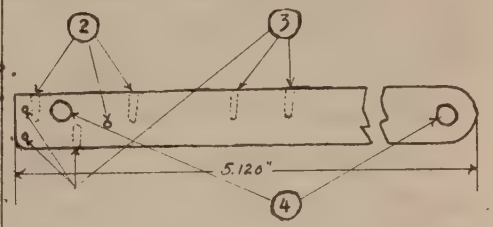
ALL TOOLS AND EQUIPMENT REQUIRED (GIVE TOOL NUMBERS)
JIG 1125-2347-590.
DRILLS, #9 HIGH SPEED
" 40 CARBON
" 48 "
CHAIR FOR OPERATOR
AIR CONNECTIONS

GAUGES REQUIRED (GIVE TOOL NUMBER)
(GIVEN BELOW UNDER REMARKS)

MATERIAL-KIND COLD DRAWN STEEL.
THICKNESS .162" WIDTH .502" GRADE "SPECIAL"

SKETCH OF PIECE AND OPERATION PERFORMED

WHEN POSSIBLE SHOW A LIGHT OUTLINE OF THE PIECE WITH A HEAVY OUTLINE OR PLAIN INDICATION OF THE OPERATIONS PERFORMED AND FINISHED CONDITION. GIVE DIMENTIONS OF CUTS WHEN NECESSARY FOR A CLEAR DESCRIPTION OF ACTUAL WORK PERFORMED.



SUB-OP. 2 DRILL AS SHOWN AT 2
" 3 " " " 3
" 4 " " " 4

#40 HOLES IN EDGES .275" DEEP.
#48 " " " .180" "

NUMBER OF MACHINES RUN BY OPERATOR ONE LUBRICANT USED WATER COMPOUND NOW USED PUMP-HEAVY FLOW

SPINDLE SPEED #1 2040 R.P.M. FEED HAND P.M. CONDITION IN WHICH WORK WILL COME TO JOB FAIRLY CLEAN AND FREE FROM CHIPS,
#2 " " " AND AS LEFT BY PREVIOUS OPERATION.
#3 " " "

ALLOWANCES RECOMMENDED PERSONAL — PER 9½ HRS 17.1 M PER HR 1.8 M PER CENT 3
FATIGUE — " " 11.4 M " 1.2 M " 2
NON DELAY — " " 57.0 M " 6.0 M " 10

REMARKS GAUGE #543, 1637, 1638, 1571, 1227, 1639, 2025, 2026, 2027, 2028-USE ANY ONE
GAUGE #1653, 1654, 1655, 1656 - USE ANY ONE. GAUGE ST393.
GAUGE #1658, 1659 --USE EITHER. GAUGE ST233.
GAUGE #1640, 1657 - USE EITHER. GAUGE 2520.
GAUGE FOR SETTING DRILLS TO DEPTH #2383, 2384, 2385, 2386 - USE ANY ONE.

SUGGESTIONS FOR BETTERMENT OF EITHER METHOD OF OPERATION OR TOOLS AND EQUIPMENT USED IN THIS STUDY JIGS TIGHTEN BY A THUMB SCREW - WOULD WORK QUICKER AND EASIER IF CHANGED TO A CAM LEVER DEVICE. (CHANGE LATER - NOT ADVISABLE NOW). ATTACH PLATE TO SIDE OF JIG TO ACT AS GAUGE FOR SETTING DRILLS TO DEPTH. (CHANGE LATER - WILL SPEED UP CHANGING OF DRILLS). MAKE COMBINED WOODEN BOX AND DRILL BLOCK, WITH HOLES IN BLOCK FOR SHARP AND DULL DRILLS - BOX TO HOLD JIG, AND BLOCK TO HOLD DRILLS-THIS FOR CONVENIENCE IN DELIVERING TO JOB, AND AVOIDING OPERATOR MIXING SHARP AND DULL DRILLS ON JOB.

SPECIAL INSTRUCTIONS FOR MACHINE ADJUSTERS, SET UP MEN AND SUPERVISORS TO COMPLETE PIECE AS PER THIS METHOD SUPERVISOR OR SET UP MAN WILL SEE THAT ALL TOOLS, GAUGES, PANS FOR FINISHED WORK, SUPPLY OF LUBRICANT AND OF UNFINISHED WORK ARE ON HAND: THAT SET UP IS CORRECTLY MADE AND WILL TURN OUT THE CORRECT STANDARD OF QUALITY, BEFORE AN OPERATOR IS ASSIGNED TO THE JOB.

INSPECTION NECESSARY TO COMPLETE PIECE AS PER THIS METHOD—BY INSPECTION SEE THAT ALL HOLES ARE DRILLED AND HOLES ARE CENTRAL IN STOCK. GAUGE LOCATION OF FULCRUM HOLE G 543, ETC. ABOVE. GAUGE DIA. OF FULCRUM HOLE G 1653, ETC. ABOVE. GAUGE LOCATION OF #40 DRILL HOLE G 2520. GAUGE DIAMETERS OF #40 DRILL HOLE G ST393: #48 DRILL HOLE G ST233: GAUGE DEPTH BY OPERATOR OF #40 DRILL HOLE G 1658 OR 1659: DEPTH OF #48 DRILL HOLE G 1640 OR 1657.

headings of the observation sheet. In establishing the conditions for the taking of the study it is essential that the observer should not only see that they are standard, but that they are such that they can be repeated at any time during the ordinary course of the work. Prior to taking any observations, it is essential that the observer make a complete record of the conditions in order that similar ones may be re-established at any time for the purpose of checking the observations that he is about to make. Such complete information not only makes possible the checking of the study while it is being taken, but checking it at some future date when the rates set on it as a basis may be questioned. If conditions are carefully noted, they may be readily re-established at any future date or at least it may be determined wherein new conditions differ.

Complete record should be made of the date of the observation, the observer, the workman and his qualifications, the method of work, and the equipment used. Wherever possible a sketch of the operation should be included and at times photographs of the operation are taken and included on the observation sheet. An example of such a photograph is shown in Fig. 58. Every possible note or dimension which may have any bearing on the manner of doing the work should be entered on the sheet. Many a study has been rendered worthless by the observer's failing to record some apparently minor dimension or condition. If the material is such, for instance a textile, that a sample may be secured and attached to the sheet, this should be done.

Taking the actual time study. At the completion of this preliminary work the observer is ready to begin the actual observations and recording of times. To secure accurate results the observer must stand in such a position that he can see exactly what the worker is doing, and as far as possible, exactly what the machine is doing also. The observer should be back of, not in front of, the employee. This will lessen the strain of being observed, which increases if the worker tends to look up to see what the observer is "doing now." Ordinarily the correct position will develop to be about 5 or 6 feet in the rear and to the right or left of the employee.

In taking the study the observer will record elapsed time on the observation sheet as indicated in the example. It will be noted that in the spaces following the elements will be found two sets of figures expressed in minutes and hundredths of a minute. Those in the upper space opposite "R" represent the continuous times, recorded as the study is made for the operation as a whole. Those in the lower space opposite "T" represent the times for the elements, which are computed from the continuous times after the observations have been completed. In the accompanying study the watch was reset to zero at the end of each operation cycle. Some feel that it is desirable to allow the watch to run continuously, and make all observations so as to show the total elapsed time from the

beginning of the study. The advantage of this is that necessarily all happenings during the progress of the operation must then be noted and explained on the observation sheet. This practice is particularly desirable in a job study for developing standard conditions, so that all interruptions that have occurred, of whatever character, may be studied with a view of prevention of recurrence.

The number of observations of any operation that are required in order to secure sufficient information will vary with the type of work involved. In the illustration there were one hundred observations taken. Usually so great a number is not necessary, although in setting rates on work repeated day after day, where the cycle is short, as in the illustration, this is not too many. This is particularly true if a number of workers are engaged on the same operation. If a comparatively long time is necessary to perform each of the elements of the operation and it is clearly seen that the operator has achieved a rhythm that results in approximately a uniform rate of work, only a few observations, for instance ten to twenty, might be necessary. This is particularly true if the job involves work on automatic machines, with but a small percentage of handling time.

Securing the time of each element. At the completion of the taking of the continuous times for whatever number of operations is decided upon the observer determines the individual time for each element from the continuous times which he has recorded on the observation sheet. It will be seen that they are secured by subtracting the continuous time recorded opposite the prior element from the continuous time for the element in question. Those individual times are usually accurate, because the stop-watch hand will make three forward moves each 0.01 minute. Thus, if the hand were stopped it would be possible to read down to 0.003 minute. However, 0.01 minute is usually a close enough observation for almost any purpose, for the observer will ordinarily read up 0.01 minute as often as he will read down 0.01 minute, and any slight errors in observation of this nature will automatically adjust themselves.

Besides the continuous method of securing times for individual elements, there are two other methods which should be mentioned, for it will be found that some time-study men prefer them, especially the second one in special cases. They are the repetitive method and the cycle method. Under the repetitive method, the observer starts the watch at the beginning of an element, stops the watch when the element is completed, and records the time of the duration of the element. When the proper time again comes for the element to occur in the operation he again starts the watch, stops it at the end of the element, and records the time taken. Unless the purpose is to take a detailed observation of one motion or element with a view to its particular improvement this method is wasteful of the observer's

time. It does not provide for the securing of information concerning delays and their causes. Furthermore, elements dovetail into each other as the work is performed, and time studies, to be just, should time the worker under actual working conditions. Timing one element at a time is not making the study under actual conditions in every respect.

The cycle method is utilized for the purpose of taking the times of very short elements. The use of this method also necessitates the taking of continuous times. The observer takes the unit times of the elements in as many cycles as there are elements, each cycle including one element less than the total number. The time for each of the elements may be found by working out the equations given below. The sum of all the cycles divided by the number of cycles less one gives the operation time. By subtracting the total time of the duration of any one cycle from the operation time, the value of the element omitted is found each time. The following is an illustration involving four elements:

Cycle 1	Elements	$a+\ b+\ c\ \ \ =0.08$
Cycle 2		$b+\ c+\ d=0.07$
Cycle 3		$a\ \ +\ c+\ d=0.10$
Cycle 4		$a+\ b\ \ +\ d=0.08$
Sum		$3a+3b+3c+3d=0.33$
Operation time		$a+\ b+\ c+\ d=0.11$
Operation time		$a+\ b+\ c+\ d=0.11$
Subtract Cycle 1		$a+\ b\ +c\ \ \ =0.08$
Time of element		$d=0.03$
Operation time		$a+\ b+\ c+\ d=0.11$
Subtract Cycle 2		$+\ b+\ c+\ d=0.07$
Time of element		$a\ \ \ =0.04$
Operation time		$a+\ b+\ c+\ d=0.11$
Subtract Cycle 3		$a\ \ +\ c+\ d=0.10$
Time of element		$b\ \ \ =0.01$
Operation time		$a+\ b+\ c+\ d=0.11$
Subtract Cycle 4		$a+\ b\ \ +\ d=0.08$
Time of element		$c\ \ \ =0.03$

Therefore: $a=0.04$
$b=0.01$
$c=0.03$
$d=0.03$

Ascertaining proper working time. All of the discussion to this point has been concerned with the recording of the times as noted by the observer and the securing of the times for the individual elements from the times recorded. We shall now deal with the securing of information as to the proper time for performing each element and the whole operation, based on the recorded elementary times. This information is secured by working over the observation sheet along the lines herein suggested, and this process should be performed before the observer's notes get cold. It will be assumed that the method of taking times, illustrated by the Corona observation sheet, has been used. There are several methods of working up the time-study results that will be described. They may be termed the "average" method, the "minimum" method, the "modal" method, and the "good time" method. They will each be described; but prior to taking them up in detail, there will be pointed out certain features which are common to them all.

The first step in any method is to throw out the "abnormal" times. These are times recorded for individual elements that are clearly in error when compared to the other times recorded. The error may be due to one of the following causes: (1) Some delay which will seldom occur or some variation in the way that the element was performed which will seldom be repeated. (2) The wandering of the worker's attention, for instance, talking with a fellow-workman. (3) Some mistake on the part of the observer in reading the watch, which can generally be noted by the fact that the time of either the preceding or succeeding element is likely to be abnormal, whereas the sum of the two abnormal times will be approximately the sum of the average times of the two elements.

The striking out of abnormal values, either higher or lower than the general average, calls for fine judgment on the part of the observer. Nevertheless, it may be assumed that any times which vary more than 25 or 30 per cent from the average may be stricken out of the calculations. On short elements it is not always practical to adhere to the percentage basis. Thus, no observations have been stricken out on the attached example. The only ones which might be excluded under the suggestion just given are the readings, which occur once each, of .05 and .10 on the last element. Inasmuch as these in no way interfere with the final result, since they are both but slightly outside the limit and balance each other, they may well be retained. There are a few kinds of work in which the abnormal values should be figured in, when working up the study. These include construction work and repair work.

All methods of computing times add certain "allowances" to the selected operation time determined upon. These allowances will be discussed later, and include: (1) Allowance for the preparation time of the machine. It will be noted that the machine will only have to be prepared

to do a job once, although the job may be repeated many times in succession. This is therefore in the form of an allowance rather than an element of the operation. (2) Allowance for necessary machine delay. (3) Allowance for fatigue of the operator. (4) Allowance for personal needs of the operator, oiling machine, etc. The addition of these allowances in no way affects the computation of the selected operation time, which is determined in one of the following ways:

According to the "average" method, which is the simplest, those individual element times which remain after the abnormal readings have been eliminated, are averaged. If the average method were used, these average times would also be the selected times and would be so indicated in the last column of the observation sheet. The selected operation time under this method is found by merely adding up the average time of the separate elements. The objection to this method is that it may make the individual element times and hence the final operation time too high, because it includes all observations other than those which were abnormal. In adding allowances, these higher times are automatically taken care of, and this method has the effect of giving too much weight to the higher times.

The "minimum" method provides for taking the absolute minimum for each element, namely, that time which, in all the observations, was the fastest for any one element, and then adding these together to get the selected operation time. In this method, therefore, the minimum time and the selected time are the same. This has the effect of materially reducing the selected time below that which would be found under the "average" method. For instance, in the illustration given, the selected time for the complete operation cycle of six elements would, under the "average" method, be 1.2648 minutes, while under the "minimum" method it would be 1.13 minutes. It is generally held that this method is too severe and not fair to the workman, even with the addition of allowances, since to choose the minimum time, which might only have occurred once out of twenty observations, usually means taking a time that is just over the 25 per cent borderline, and is not quite thrown out.

The "modal" method is one of the two most frequently used. It consists of taking the most frequently recurring element time in the observations as the time for that element. Thus, in element six in the illustration, the time .07 recurs 47 times, whereas the times which recur next most frequently are .08, 34 times and .06, 13 times. Therefore, .07 would be taken as the selected time for that element. The selected operation time is secured by adding together the various element times, thus secured. If two elements recur with equal frequency, usually the average of these elements is taken. Under this method, the selected times for the elements in the illustration would be as follows:

1—.10 (40 times)
2—.33 (30 times)
3—.54 (29 times)
4—.16 (40 times)
5—.06 (43 times)
6—.07 (47 times)

The selected operation time in this case would, therefore, be 1.26 minutes, which is just less than the average time. Usually the modal time is more pronouncedly less than the average time and is, of course, always greater than the time secured by the " minimum " method. It is claimed that the modal method eliminates the objections to the two previous methods, and at the same time gives a selected time which can be achieved, as is evidenced by the fact that it is composed of the elementary times which were themselves most frequently achieved.

The " good time " method is merely the modal method applied with some degree of flexibility. In the " good time " method a time which recurs with reasonable frequency is selected rather than the one which happens to occur most frequently. The fact that the time recurs a number of times indicates that it can be made, and the justice of this method lies entirely in the interpretation of reasonable. A time to be reasonable certainly should appear in from 10 to 15 per cent of the observations. The time selected might presumably be the modal time, but it is likely to be somewhat lower. In the illustration, but one element would be changed, but this is somewhat unusual. That element would be number three, where .52 occurred 25 times, .53 occurred 28 times, and .54 occurred 29 times. .53 has been selected, thus making the selected time for the whole operation 1.25 minutes, as indicated.

CHAPTER XX

TIME-STUDY ALLOWANCES

As was previously indicated, there must be added to the ascertained selected operation time certain allowances, through which provision is made that the task time set for a job shall be capable of accomplishment over long periods. These allowances, for instance, the preparation allowances, may partially be determined with as much exactness as the selected time. On the other hand, the provision of proper allowance for machine delay, fatigue, and personal needs must involve as an element the judgment of the person who computes the allowance. Therefore, if care be not utilized in the making of the allowances, any amount of care utilized in timing of the operation or selecting the unit times may be negatived.

To secure background for the determination of the proper allowances it is necessary to again review the purposes for which time studies are taken and to see the relation of the selected operation time to these. The taking of time studies for the purpose of setting rates furnishes a basis on which definite tasks may be set. The selected operation time is the time under which the operation could be performed by a highly skilled worker under ideal conditions. It is a time that can be "made," but not one which is usually made. This manifestly would be an unfair basis for the setting of rates. It is desired to fix a time which will be within the ability of any worker, properly instructed. This time is secured by adding the allowances to the selected operation time, and is known as "task time."

The measure of the fairness of the task which has been set is the ability of the average worker to make it, and the ability of the extra-skilled worker, working under good conditions, to better it. The purpose of time study is to set a time which may cause the worker to accomplish the maximum amount of work with the minimum amount of fatigue, as only with such a task basis can maximum production be maintained day after day. The selected operation time is not such a basis, but would only be a basis for setting a task for a highly skilled worker, working under ideal conditions.

It will be well to note carefully this relationship of allowances to the time set, for one of the chief criticisms leveled at time study has been that it set a rate which only the best workers could hope to achieve. The

addition of proper allowances brings time-setting into entirely another category. Time study sets a rate which the average worker should be able to better consistently if he is properly trained, and the better workers will be able to consistently approach the selected operation time. Indeed, some newer wage systems depend for their operation upon the fact that the task time can frequently be bettered.

Preparation time allowance. The first allowance which may be made is for preparation time. In any type of work which is not purely a manual job there is involved some preparation of the machine to receive the work that is to be done. The " set-up " of the machine from the last job must be changed. The importance of this, the length of time that it takes, and the frequency with which it must be carried on, differ from job to job and from industry to industry. Preparation time may not always be treated as an allowance. The preparation of the machine may in some cases be regarded as a separate operation, or it may be wisest to regard it as an element of the operation to be performed. This should be clear with the following illustrations.

In a textile mill the preparation of a loom to run a particular style of fabric is a job which may have to be performed only at relatively long intervals. The job has to be performed at most only when a warp has run out and a new warp must be placed in the loom. Since warps are frequently over 1000 yards long, this task may only have to be performed every two or three weeks, and then, when it is performed, it may take a day or the greater part thereof. When the preparation of the machine occurs so seldom as this, and is such a long task when it does occur, it is wise to regard it as a separate operation, rather than to endeavor to make an allowance for preparation time.

In a paper mill, in the beating operation, where the fibers of the pulp are put into such condition that they will interweave with each other and " felt " on the moving wire of the Fourdrinier machine, the knives of the beating engine must be set differently for different grades of product. Thus the beating engine must be prepared to receive each batch of pulp, provided that different grades of pulp are worked in the same beater. But the beating operation takes only a few hours, as contrasted to the weaving operation just spoken of, and the preparation of the beater takes only a comparatively short time, when contrasted to the time taken by the operation itself. Inasmuch as the preparation must be taken care of on each operation, it would be unwise to make a preparation allowance, and on the other hand it would be incorrect to treat the preparation as a separate operation. In such cases, therefore, by far the best plan is to treat the preparation of the machine as the first element in the operation being studied.

In by far the largest number of operations, the machine is " set-up "

once and then the operation is performed several or a number of times in succession prior to the resetting of the machine. It is in such cases that a preparation *allowance* is necessary. Illustrations of such jobs are to be found profusely in many industries, for instance, in shoe-manufacturing and in any work requiring the use of machine tools. The " pulling over " machine in a shoe factory must be reset for each type of shoe being worked upon. But many dozen shoes are worked on prior to the resetting of the machine. If the operation being studied is the pulling-over of a shoe, it will be seen that the preparation time of the machine must be figured in the necessary time for the performance of the operation, but that it may be figured in terms of an allowance. There should be determined, as in the case of the loom, the length of time it takes to set up the machine, as though it were a separate operation. This amount may then be divided by the number of shoes being made in a given case, and the result may be added to the selected operation time taken to work one shoe, so that each shoe may bear its proper part of the time that it takes to set up the machine to work on the whole lot. For instance, if the set-up time is found to be 48 minutes, and there are 20 dozen shoes being run through, the preparation allowance would be .2 minute per shoe. If 40 dozen shoes were to be run through before the machine were reset, the preparation allowance would be .1 minute per shoe.

Allowance for personal needs. The allowance for the personal needs of the workman is usually constructed so as to take care also of the regular oiling and care of the machine. This allowance is sometimes known as the " shop constant " because it is usually the same for all operations in the shop. It is ordinarily based on a percentage between 2 and 3 per cent of the selected operation time.

Delay allowances. Delay allowances include allowances for the fatigue of the operator caused by those portions of the operation which are manual in nature, and machine delay allowances for delays due to difficulties with machines or equipment, which may be outside the control of the operator. It is in the making of the delay allowances that the most care is needed, because these may be so large that unless they are carefully set, all the previous care taken in making and working up the study may be wasted. Why carefully record element times to 0.01 of a minute, and then add a delay allowance of " between 20 and 50 per cent at the discretion of the observer, based on his opinion as he took the study "? Yet many time studies have been worked up on that basis. It is one of the commonest practices connected with time study. It is also one of the chief causes of criticism of time-study work, as practiced. Many shafts of laughter have been leveled at the idea of being accurate to hundredths of a minute and then arbitrarily adding 50 per cent to the resulting calculations.

Fatigue allowances. In setting the fatigue allowance there are a

number of factors to be considered. The first of these is the working conditions. If these are excellent, that is, if the shop is cleanly, well lighted, and well ventilated, they may be disregarded. If these conditions are not right and cannot be immediately made right, allowance must be made. The next factor is the length of the cycle of the operation. In general, the shorter the cycle, the greater the necessary fatigue allowance. The amount of physical exertion required must also be considered. If a job requires much physical exertion the influence of the fatigue factor is large. However, on such jobs, the original study should extend over a large portion of a day, in order that the fatigue factor may influence directly the selected operation time. The presence or absence of stated rest periods should also be considered.

The study of fatigue. The fatigue of workers is the uncontrollable item which has made difficult all attempts to develop standard task times which will hold over long periods. Attempts to make high wages on piece rates, and enthusiasm upon the part of the worker may both contribute toward the setting of a task time which seems possible of achievement over long periods, whereas it is really attainable only in spurts. Although the quantitative measurement of fatigue has not been successfully carried on as yet on a large scale, it is nevertheless desirable to briefly consider this factor, its causes, and the means of prevention, in order to more intelligently develop fatigue allowances in setting standard time, and in order that a fundamental philosophy toward the amount which a worker should be called upon to do may be developed.

Physiologically speaking, fatigue is the result of poisonous waste matter in the system and, since all labor produces this waste matter, to eliminate fatigue is to eliminate labor. There are two kinds of fatigue, normal and cumulative. Normal fatigue is weariness that is overcome by rest and need not be considered as an industrial problem, as it may even be thought of as a wholesome fatigue which is similar to the pleasure derived from exertion in sports. Cumulative fatigue, resulting from overstrain, can be either caused by too much work or too sustained work, and some psychologists claim that it can also be caused through monotony in work. As fatigue has not been successfully measured quantitatively on a large scale, it is difficult to distinguish normal fatigue from cumulative fatigue, and this is the factor which makes fatigue elimination so difficult.

Signs of the presence of cumulative fatigue may be found in a study of production or accident records within an organization. If production tends to fall toward the end of the day or the end of the week, or if accidents seem to be unduly high at some times, it may be assumed that in the operations affected there is some cumulative fatigue which should be eliminated. These guides, particularly the guide of decreased production, may not be sufficient to detect the presence or absence of cumulative fatigue. This is

particularly true on piecework. Pieceworkers, who have set a goal for themselves, are very likely to aim to reach this goal regardless of their physical condition, and the curves of production of pieceworkers, because of this fact, tend to go up at noon and at the end of the day. The workers with largest production under piecework are likely to be those who are building up an accumulation of overstrain, to the point where they leave the plant either because " the work is getting on their nerves " or for other stated reasons which have the same general foundation.

It is to be hoped that there will soon be a practical quantitative measurement of cumulative fatigue which will allow fatigue allowances in time study to be set with complete assurance, rather than partially on judgment. Without intelligent thought on the subject of the fatigue allowance, there is no positive check at present on the setting of a time which will produce cumulative fatigue. Practically, this is no great difficulty, since the intelligent time-study man can, by careful observation and analysis, prevent the evils of cumulative fatigue, such as pieceworkers would be likely to subject themselves to were it not for the job studies. Nevertheless, if there were some accurate measurement of quantitive fatigue, there might be more satisfaction, both for the job-study men and the workers for whom fatigue allowances are set.

All tests of fatigue, except one, seem to be valueless in this connection. Most tests, because they depend partially upon the will or the strength of the worker, have made it possible for the worker to artificially change real conditions while the test is in progress. For instance, such tests include strength tests or mental tests.

A quantitative test for fatigue. Dr. A. H. Ryan, of the Scovill Manufacturing Company, Waterbury, Conn., has to date made the most promising contribution toward the quantitative measurement of industrial fatigue. He has utilized a vascular skin reaction test which seems to give a fair measure of the extent of fatigue of a worker. This test consists in making a stroke on the surface of the forearm of the worker with a blunt instrument so devised that the stroke can always be made with the same pressure. The white streak which results from this stroke is studied with regard to its latent period, the time required for it to reach its maximum intensity, and the time at which it begins to spread and fade. The test seems to be somewhat successful, since the time elapsed before fading is decreased by work and activity, and increased by rest or sleep. The positive checks which to date have been made on this test seem to indicate that work which was considered the heaviest by foremen showed the greatest fatigue by the test; secondly, the fatigue seems to vary generally with the amount of output, providing the workers are working up to capacity; and, thirdly, in a comparison of percentages of accidents and illness on various jobs in consecutive years of employment, in the jobs

showing the least fatigue by the vascular skin reaction, there was no rise in accidents or illness in three years of consecutive employment, whereas in jobs showing the greatest fatigue there was a rise in the percentage of accidents and illness. This arouses hope for the securing of a practical measurement of cumulative fatigue.

Rest periods. Fatigue elimination to date has largely consisted of the bettering of equipment, as discussed under standard equipment, the elimination of useless and tiring motions, as developed by job study, and the provision of rest periods. Rest periods have been developed with the thought that workers in industry have been their own trainers too long. Just as the athlete finds it necessary to secure the advice of others concerning when he should work and when he should rest, so it is with the worker who attempts to reach maximum production day after day. If allowed to train himself, he may readily get out of condition, and thus the idea of rest periods develops.

Three general types of rest periods have been developed, namely, stated rest while working on the job, a change in the type of work, and stated rest periods at the middle of the morning or at the middle of the afternoon. As an example of stated rest on the job may be given an experience of a contracting firm in Pittsburgh in the erection of steel-frame buildings. This firm determined to introduce a rest period of two minutes for its riveters after each ten rivets had been driven in. This involved approximately $1\frac{3}{4}$ minutes' work out of each $3\frac{3}{4}$ minutes. The result was an increase in the amount of rivets driven of 125 per cent per man.

Rest periods involving change in type of work may involve a change of tasks. This is particularly desirable, if possible, with those workers who must perform the same operation day in and day out. It may involve having the worker secure and deliver his own material. It is not always profitable to bring material directly to the tool point of a worker and to take that material away from the tool point of the worker; this is particularly true if the worker must remain in the same position at all times because of the nature of his machine. Thus, at the Joseph & Feiss Company, in Cleveland, it has been found desirable to allow girls working on various operations in the manufacture of clothing to secure batches of material from control desks, and to deliver these batches, when finished, back to the control desk, rather than to have persons move this material to and fro for the worker. Of course, this necessitates the determination of the proper size of batch, both from the standpoint of operations in the shop and from the standpoint of the elimination of fatigue, and this can only be determined after trial. Furthermore, such considerations must be closely controlled, or much confusion within the workroom will be likely to result. If the task be such that the worker may either sit or stand when performing it, it is probable that such a plan will not be necessary.

Stated rest periods of five, ten, or fifteen minutes during the morning and afternoon grew very popular during the war, and have since been retained in a large number of plants in which they were instituted at that time. There was a great deal of reaction against this type of rest period immediately following the war, because it had been instituted frequently under conditions which were not suitable for it. It is only satisfactory where machinery can be stopped and started at a given time. This holds particularly true with regard to the stoppage of machinery in the case of pieceworkers, and the starting of machinery with day workers. Furthermore, such rest periods seem to be most successful when the workers affected are women rather than men. Though rest periods do not result in the scientific elimination of cumulative fatigue they do offer a palliative which is similar in effect to that of the noon hour. In cases where production falls immediately before the noon hour and in the late afternoon, or where accidents seem to be greater at these times, it will be found usually that such rest periods will even up the curve of production, and reduce accidents throughout the day without a diminution of total output.

Machine-delay allowances. In determining the machine-delay allowance, the percentage of machine time, as contrasted to the manual or "handling" time, should be taken into account. If the machine time be large, the machine-delay allowance must be correspondingly large, because of the greater likelihood of stoppages outside the control of the operator. Since this allowance makes provision for all details outside the control of the operator, it will necessarily be smaller in plants having well-developed planning departments and where material and equipment standardization has been given most consideration. The 10 per cent allowance made in the accompanying illustration from the Corona plant is relatively low and could not be justified in a plant which had not made the progress in these other phases of management work that have been made in this organization.

The correct percentages of delay allowances in any shop may best be determined by intelligent consideration of the first jobs studied and on the basis of the experience on these jobs for later jobs. That is, after jobs have been studied, and standard task times put into effect for them, record should be carefully made of operators' performances, and these should be compared for all jobs of similar percentages of machine time and for similar cycles and amount of physical exertion required. If the percentage increases of actual handling and machine times be thus compared with selected times, excellent data will be secured for the setting of delay allowances. The most scientific work along these lines has been done by Mr. Dwight V. Merrick under the direction of Mr. Carl Barth.[1]

[1] See Merrick, D. V., "Time Studies for Rate Setting," Engineering Magazine Co., pp. 17 and 60–65.

Total task time. After the allowances have been computed the total task time which is set as a standard for the operation is computed by adding the allowances to the selected operation time. Thus the task time the illustration is found to be:

	Minutes
Selected operation time	1.25
Preparation time (not distributed)	.....
Personal needs (3%)	.0375
Fatigue allowance (2%)	.025
Machine delay (10%)	.125
Task Time	1.4375

CHAPTER XXI

UTILIZATION OF TIME-STUDY DATA

Regrouping old elements to set times on new operations. In shops manufacturing diverse products, it is impractical to take time studies on many orders being manufactured, both because of the cost and the promise of early delivery dates. It was previously shown that if the operations, when studied, are divided into their basic elements, these element times may be regrouped, and operation times set for new operations without further study. To be in a position to compile task times in this way implies not only excellent studies to begin with, but a well-worked-out filing system for the data that have been secured. Standard nomenclature of operations is a great aid here. Many concerns have been extremely successful in setting tasks in this way, as, for instance, The Link Belt Company, which, in its Philadelphia plant, has been enabled to set rates on new products by time study extremely successfully, despite the fact that very few new studies have been made during the last five or six years.

Much opposition is likely to develop to setting rates by a regrouping of elements unless this is excellently handled. It will be found true that there are comparatively few elementary operations performed in most trades, but that there are a great many combinations in which these few elementary operations may be performed. Nevertheless, great care must be exercised in this reuse of time-study data to insure that the element in question is in reality the same element which has been previously studied, and that the conditions surrounding the new job are of such a nature that the previously secured information may be freely utilized without injustice to either the workmen or the management.

Setting standard rates. Time studies of the kind which have been discussed are taken not only for the purpose of improving conditions, but for the purpose of setting just and equable relative rates on jobs. The fundamental consideration in rate-setting is that a rate once set may never be cut by the management. Any other policy results in workers fearing to turn out maximum production, lest the rate be cut and they receive no added compensation for added effort. When methods of wage payment are discussed in detail, more will be said about rate-cutting. The important point here is to note the responsibility that exists in the time-study department to see that their recommendations for standard

times are accurate, as an error which makes a "soft job" may cause a long-time sore spot in the rate system of the plant. The actual setting of the rate may be in the hands of the superintendent or the works manager of a plant, and he may be assisted by the personnel department in its final determination. It is the methods department, or whatever department of the plant actually makes the time studies, which has the real responsibility on its hands. Some system of proposal for a standard rate by this department is usually in vogue, and the accompanying illustration of a standard rate proposal from the Corona plant (Fig. 55) is an excellent example. It will be noted that the proposed rate covers the same job as the illustration previously used in connection with job studies. The rate is only approved by the works manager after it has been carefully checked by the chief of the planning department and himself.

Some guarantee should be given the workman that the rate set will not be cut. This is usually placed on the instruction card which he receives. The policy of the Corona Company is an excellent example of what plant policy should be in rate guarantees, and the printed guarantee which goes to the workman along with the instruction card is reproduced in Fig. 56.

Instruction cards. The preparation and distribution to the worker of instruction cards, carefully detailing the method of work on a job, as well as the time that the various elements should take and the rate of pay, is an important follow-up of time-study work. This insures the utilization of the standard methods which have been devised during the job study and gives to each worker the best knowledge on methods of performance. It does not preclude innovation on the part of the worker, since he may recommend betterments, but it does insure that any new methods which are used will be better than old ones and that they will be equally available to all workers on a particular task. Some incentive must be offered to the worker to suggest betterments; he may possibly be allowed to personally retain the full benefits of any new methods which he may discover.

Two forms of instruction cards are illustrated. The one used by the Corona Company (Fig. 57) is a logical follow-up of their whole method of making job studies. The one used at the Jones & Lamson Company (Fig. 58) shows only one side of the card and shows how pictures of the set-up may be included on the instruction card as an additional guide to the worker. Instruction cards should always contain all information gained from the job study, as to proper set-up, speeds, and feeds. The selected times of the elements should appear, in order that the workman may see the possibilities of performance that lie in the job. All computations of allowances should also be indicated on the card, in order that it may be perfectly clear how the task time was computed. On work which does not involve much repetition, it is extremely important to impress the operator with the plan to be followed, so that the worker will not lose much

166-7176-1500 12-20

PROPOSAL FOR STANDARD RATE AND TIME ALLOWANCE

CORONA TYPEWRITER COMPANY, INC.

OPERATION #4 DRILL ALL HOLES. PART NO. 2X92.

TO COST DEPARTMENT: DATE 8 - 5 - 1920

Please furnish the Method and Instruction Card Division with costs of the above operation as follows:-

	PER 100 PIECES			
	MATERIAL	DIRECT LABOR	BURDEN	TOTAL COST
AVERAGE COST FOR LAST SIX MONTHS PREVIOUS TO 8 - 1 - 1920.	-	$ 2.64	-	-
" " " " THREE " " " " 19 "	-	2.473	-	-
HIGHEST " " " " " 19 "	-	3.161	-	-
LOWEST " " " " " 19 "	-	1.922	-	-

PRESENT RATE PAID AT PIECE WORK $ NONE FOR EACH 100 PIECES. PRESENT BASE RATE NONE PER HR.

REMARKS THIS OPERATION IS NOT SET ON PIECE WORK - FIGURES GIVEN ABOVE ARE FROM WAGE PAYMENTS OF HOURLY RATES.

REQUESTED BY H. V. WILLIAMS DEPT. 52

To be filled in by Methods and Instruction Card Division

	PER 100 PIECES		
	HOURS AT P. W.	HOURS AT D. W	TOTAL AVERAGE
AVERAGE TIME TAKEN DURING LAST SIX MONTHS PREVIOUS TO 8 - 1 - 1920.	-	6.60	6.60
" " " " THREE " " " " 19 "	-	5.82	5.82
HIGHEST " " " " " 19 "	-	7.23	7.23
LOWEST " " " " " 19 "	-	4.80	4.80

PRESENT STANDARD TIME ALLOWED NONE HRS. PER 100 PIECES PRESENT CLASS OF LABOR MALE

REMARKS FIGURES GIVEN ABOVE ARE FROM OPERATION RUNNING ON AN HOURLY RATE BASIS.

PROPOSAL BASED ON OBSERVATION SHEETS 8 - 10 - 1920.

PROPOSED STANDARD TIME ALLOWANCE 2.39 HRS. FOR EACH 100 PIECES

PROPOSED STANDARD RATE TO BE PAID $ 1.278 FOR EACH 100 PIECES

PROPOSED BASE RATE AT 100% EFFICIENCY $ .533 PER HOUR

PROPOSED CLASS OF LABOR MALE

	AT 100% EFF.	AT 80% EFF.	AT 120% EFF.
PRODUCTION REQUIRED PER HOUR	41.75 PIECES	33.4 PIECES	50.1 PIECES
" " " 8½ HOUR DAY	396.6 "	317.3 "	475.9 "
" " " 82½ " WEEK	2191.8 "	1753.5 "	2630.2 "
EARNINGS PER HOUR	$ .533 "	$ .426 "	$ .639 "
" " " 8½ HOUR DAY	$ 5.06 "	$ 4.04 "	$ 6.07 "
" " " 82½ " WEEK	$ 27.98 "	$ 22.36 "	$ 33.54 "

ESTIMATED LARGEST FIGURES TO BE MADE ON THIS JOB --- EFFICIENCY 115 % EARNINGS $ .612 PER HOUR

ALLOWANCE MADE:		M. PER HR.	M. PER 8½ HR. DAY	M. PER 82½ HR. WEEK
--- PERSONAL	1.8	17.1	94.5	
" --- FATIGUE	1.2	11.4	63.0	
" --- MACHINE & TOOL	6.0	57.0	315.0	
" --- INSPECTION	-	-	-	
" ---	-	-	-	
TOTAL ALLOWANCES	9.0	85.5	472.5	

FIG. 55.

Actual working time required (minus all allowances):-

PER HOUR 51 MIN. PER 9½ HOUR DAY 8 HRS. 4.5 MIN. PER 52½ HR. WEEK 44 HRS. 37.5 MIN

Load in production due to allowances :-

PER HOUR 6.257 PIECES. PER 9½ HOUR DAY 59.44 PIECES. PER 52½ HR WEEK 328.49 PIECES.

GAIN or LOSS made by this proposal (at 100% Eff.)

GAIN IN PRODUCTION OF 24.57 PIECES PER HOUR COMPARED WITH FIGURES FOR LAST 3 MO'S PREVIOUS TO 8-1-20.

LOWER DIRECT COST BY $ 1.195 PER 100 PIECES - - - - - 3 - - 8-1-20.

LOWER "TIME OF 3.43 HRS. PER HR. - - - - - 3 - - 8-1-20.

GAIN TO OPERATOR DUE TO OPPORTUNITY TO INCREASE WAGES THROUGH PIECE WORK AND USE OF HIS TIME TO BETTER ADVANTAGE.

STATEMENT OF REASONS FOR CHANGE IN STANDARD AND GAINS OR LOSSES MADE:-

THIS OPERATION HAS NOT PREVIOUSLY BEEN SET ON PIECE WORK.
FROM THE GIVEN FIGURES, IT WILL BE OBSERVED THAT, UNDER THE METHOD OF PAYMENT BY HOURLY RATES, THERE HAS BEEN A VAST VARIATION IN THE OUTPUT OBTAINED PER HOUR AND THE COST PER UNIT - THIS VARIATION EXISTING WITH ALL OPERATORS TO A GREATER OR LESS EXTENT.
TO CORRECT THIS, IT IS PROPOSED THAT A STANDARD TIME AND RATE, AS GIVEN BE PLACED ON THIS OPERATION - COMPLETION OF THIS WORK IN ACCORDANCE WITH THIS STANDARD AT 100% EFFICIENCY, WILL RESULT AS FOLLOWS:- AN INCREASE OF 24.57 PIECES PER HOUR IN OUTPUT; A DECREASE IN COST OF $1.195 PER 100 PIECES AND A SAVING IN TIME OF 3.43 HOURS FOR EACH 100 PIECES PROCESSED, WHEN COMPARED WITH THE CONDITIONS EXISTING DURING THE THREE MONTHS PREVIOUS. ON A BASIS OF AN ESTIMATED YEARLY PRODUCTION OF 100,000 UNITS, THIS WILL EQUAL A SAVING IN TIME OF 3430 MAN HOURS AND A SAVING IN DIRECT WAGE OF $1195. (NOTE-THE PROPORTION OF DIFFERENCE BETWEEN THE HOURS SAVED AND THE WAGE SAVED, IS DUE TO THE ESTABLISHING OF A BASE WAGE AT 100% EFFICIENCY CONSIDERABLY HIGHER THAN THE AVERAGE HOURLY RATES PREVAILING UNDER DAY WORK CONDITIONS, THUS ABSORBING A LARGE PART OF THE ACTUAL MONEY SAVING MADE.)

THESE PROPOSED SAVINGS ARE MADE THROUGH SIMPLIFICATION AND ELIMINATION OF UNNECESSARY MOVEMENTS AND GREATER APPLICATION OF THE OPERATOR TO THE JOB, THROUGH THE STIMULUS OF PIECE WORK.

NO EXPENSE IS INCURRED FOR NEW TOOLS OR EQUIPMENT OTHER THAN A TOTE BOX FOR DELIVERY OF TOOLS TO JOB - ESTMATED AS $.75 CENTS.

NO CHANGE IN STANDARD TIME OR RATE WILL BE MADE BY THE TIME STUDY DIVISION ON ANY JOB UNLESS THE PROPOSED SCHEDULE IS AUTHORIZED BY PLANNING ENGINEER'S AND WORKS MANAGER'S SIGNATURE.

WRITTEN BY H. V. WILLIAMS DATE 8-12-20.
TIME STUDY DIVISION

ACCEPTED BY _____

PLAN ENG

WKS MGR

time in planning his work. On work which is repetitive the worker will have occasion to refer to the instruction card less frequently, as he will soon familiarize himself with all the information upon it, but the card should be issued and be referred to by the supervisors as a continual check on standard method.

The worker as an aid in checking time studies. To place full information concerning the methods of computing the task time upon the instruction card is one of the best self-imposed checks that a time-study department could possibly place upon itself. If this department is disposed to be unfair to the workman it becomes more difficult to be so when the computations of task time are subject to the inspection of the worker. On

The Corona Typewriter Co., Inc., agrees to pay the rate per 100 pieces as stated on any ***Instruction Card***, only on condition that the method followed by the operator is in accordance with the conditions and instructions specified on the ***Instruction Card***, and, the Corona Typewriter Co. Inc., also agrees to make no reduction in the rate of wage payment as long as the given operation conditions, instructions for operator, class of labor required and quality of work specified, remain in effect.

Supervisors and Assistants are instructed to cancel Piece Rate payments on all Job Cost tickets whereon the conditions, the method followed by the operator, or the class of labor assigned to the work is not in accordance with that specified on the ***Instruction Card*** or where the quality of work turned out by the operator does not equal the acceptable standard. Both Supervisors and Assistants are held strictly responsible for the enforcement of the above ruling.

The Management recognizes that there may be methods that are better or more economical than those contained in the ***Instruction Card*** and employees are requested to send any suggestions that they may have for betterment to the Planning Department, where they will be given full consideration.

FIG. 56.—Rate Guarantee.

the other hand, giving the worker a copy of the time-study results indicates to him that the time-study man was "square." Such procedure absolutely precludes the practice, which has been followed in some plants, of arbitrarily reducing task time in order to overspeed workmen. This action must be coupled with the idea that the workman may call attention to element selected times which he feels are unjust and unreachable. If it were always possible to use only the one workman who was time-studied for the particular job all this precaution would be unnecessary, but since this is impossible every precaution is necessary to insure full and hearty response from each workman.

There is frequently a complaint made by some operator that he is unable to reach the standard of performance that has been called for on the

instruction card. This may be due to one of the following causes or a combination of several of them: lack of skill on the part of the operator, trouble with his machine or equipment, delays which may have passed unobserved on the part of the time-study observer because they did not happen to occur while the study was being taken, or an incorrect time study. If an operator seems to be unable to make his task time with any degree of regularity, and it is clearly not his fault on the face of conditions, it is essential that a new study be made to check the time study that has been taken, so that it may be finally determined whether or not the task time that has been set is a fair one. The new study that is made has been termed by some time-study men a "production study." It usually consists of the observation of the operator during an entire day's time, or such part of the day as he is working on the operation concerning which he has made complaint.

During the observation of the worker in this "production study" a careful record is made of all times consumed, including a record of the element times, in the same way that these were recorded when the time study was originally taken. The particular value of this type of study is twofold: An opportunity is given to check the task at another time and therefore to see whether the delays which occur are practically the same and caused in the same way as those noticed when the study was originally taken; and second, an opportunity is given to see the effect of fatigue upon the worker, inasmuch as the study covers an entire day, which is an unusual length of time for an ordinary time study. A production study is, therefore, quite as much a fatigue study as it is a job study, and in reality consists of a combination of the two. It may conceivably happen that a time study which was accurate for jobs when they lasted only for several hours will prove to be absolutely incorrect for the same jobs when they are carried on throughout an entire day, because of the cumulative fatigue caused by carrying on the job for that length of time.

In order to insure accuracy in a production study it is necessary that the element times be checked up against the selected element times of the original time study. The observer will usually do this, to some extent, as he goes along, so that if there are any great discrepancies he will be enabled to see the cause of these during the time that he is taking the study. On the other hand, much of the results of the production study can only be secured by working up of the data at its conclusion. The charting of the times consumed during certain hours of the morning and the afternoon may give the necessary information concerning fatigue upon which to base recommendations of change in time allowed for the task, or possibly on which to recommend relief from fatigue by means of rest periods.

Often interesting data will be obtained from the production study which

214-7565-300M-4-23

INSTRUCTION CARD FOR METHOD OF OPERATION

Corona Typewriter Company, Inc.

Date Issued 8 - 23 - 19 20. DRILLING Dept's copy Part No. 2X92

Operation No. 4 Name DRILL ALL HOLES.

Time allowed at 100% efficiency for 100 pieces 2.39 Hours Rate paid for 100 pieces $ 1.278

Output required at 100% efficiency 41.75 pieces per hour Earnings at 100% efficiency $ .533 per hour

Time allowed on route board for 1000 pieces at 80% efficiency 29.88 Hours

DETAIL OF METHOD OF OPERATION	100% TIME ALLOWED
OPERATOR WORKS SITTING DOWN.	
1. PICK UP ONE UNFINISHED PIECE FROM PAN ON TABLE, WITH LEFT HAND, PLACE IN JIG AND LOCK JIG.	.10
2. SLIDE JIG UNDER FIRST SPINDLE, DRILL TWO #40 HOLES IN TOP EDGE. TURN JIG ½ OVER, DRILL ONE #40 HOLE THROUGH SIDE.	.33
3. SLIDE JIG UNDER SECOND SPINDLE, DRILL TWO #48 HOLES THROUGH SIDE. TURN JIG ½ OVER, DRILL TWO #48 HOLES IN TOP EDGE. TURN JIG ½ OVER, DRILL ONE #48 HOLE IN BOTTOM EDGE,	.53
4. TURN JIG ½ OVER, SLIDE UNDER THIRD SPINDLE, DRILL TWO #9 HOLES.	.16
5. TURN JIG ½ OVER, UNLOCK JIG, REMOVE FINISHED PIECE AND THROW IN PAN FOR FINISHED WORK ON TABLE.	.06
6. BLOW ALL CHIPS FROM JIG WITH COMPRESSED AIR.	.07
REST ALLOWANCE @ 5%	.0625
MACHINE AND TOOL DELAY ALLOWANCE @ 10%	.125
(NOTE - ALL SPINDLES ARE OPERATED WITH HAND LEVERS. KEEP A HEAVY FLOW OF LUBRICANT ON DRILLS. KEEP MACHINE TABLE FREE FROM CHIPS, SO JIG WILL SET SQUARELY TEST DEPTH AND DIAMETER OF TWO HOLES AFTER EACH CHANGE OF #40 OR #48 DRILL)	
TOTAL TIME ALLOWED FOR ONE PIECES	1.4375

Inspection Instructions WALKING INSPECTOR:-SEE THAT ALL HOLES ARE DRILLED AND HOLES ARE CENTRAL IN STOCK. GAUGE LOCATION OF FULCRUM HOLE G543,ETC. GAUGE DIA. OF FULCRUM HOLE G1653,ETC. GAUGE LOCATION OF #40 DRILL HOLE G2520. GAUGE DIAMETERS OF #40 DRILL HOLE G.ST393: #48 DRILL HOLE G.ST233. GAUGE DEPTH OF #40 DRILL HOLE G1658 OR 1659: DEPTH OF #48 DRILL HOLE G1640 OR 1657.

NOTE--OPERATORS WILL NOT BE PAID FOR WORK REJECTED BY INSPECTORS ON ACCOUNT OF DEFECTIVE WORKMANSHIP

If Operation or instructions can not be performed as outlined or changes are required, notify the methods Division of the Planning Department immediately.

Method Approved T. M. JONES. Methods Div. Date 8 - 23 -20.

Rate and instructions approved B.R. BIGELOW. Instruction Div. Date 8 - 23 -20.

FIG. 57.

MACHINE AND SET UP INSTRUCTIONS

Machines (on which job can run piece work) 040301-2-3-4-5-6. 040401-2-3-4.

Emergency machines (on which job can be run, but not on piece work) ANY OTHER DRILL PRESS, HOWEVER ALL ARE INCONVENIENT AND SHOULD BE USED ONLY AS A LAST RESORT.

Location of finished work IN PAN ON TABLE, LOCATED AT RIGHT OF OPERATOR.

Location of unfinished work " " " " " " LEFT " "

Condition in which work will come to job FAIRLY CLEAN AND FREE FROM CHIPS.

Material-Kind COLD DRAWN STEEL. Thickness .162" Width .502" Grade SPECIAL

Number of machines run by operator ONE Lubricant used WATER COMPOUND How used PUMP-HEAVY FLOW.

Spindle #1 Speed 2040 R. P. M. Feed HAND P. M. Frequency of sharpening Tools AS NECESSARY - ALL DRILLS
#2 " " " " " " WILL BE OBTAINED FROM TOOL CRIB, SHARP
#3 " " " " " " AND READY FOR IMMEDIATE USE.
" " " " " " "

Tools located in tool Crib No. 3

All Tools, Equipment and gauges required (Give all Toof numbers) JIG 1125,2347,590-USE ANY ONE.
GAUGE 543,1637,1638,1571,1227,1639,2025,2026,2027,2028-USE ANY ONE.
GAUGE 1653,1654,1655 1656-USE ANY ONE. CHAIR FOR OPERATOR.
GAUGE 1658,1659-USE EITHER. DRILLS, #9 H.S.,#40 AND #48 CARBON.
GAUGE 1640,1657-USE EITHER. AIR CONNECTIONS.
GAUGE ST393. GAUGE 2520.
GAUGE ST233. DRILL SETTING GAUGE 2383,2384,2385,2386-USE ANY ONE.

INSTRUCTIONS FOR SET UP OF JOB

TOTAL TIME ALLOWED AT 100% EFFICIENCY - - - - HOURS RATE PAID PER HOUR AT 100% EFFICIENCY - - - -

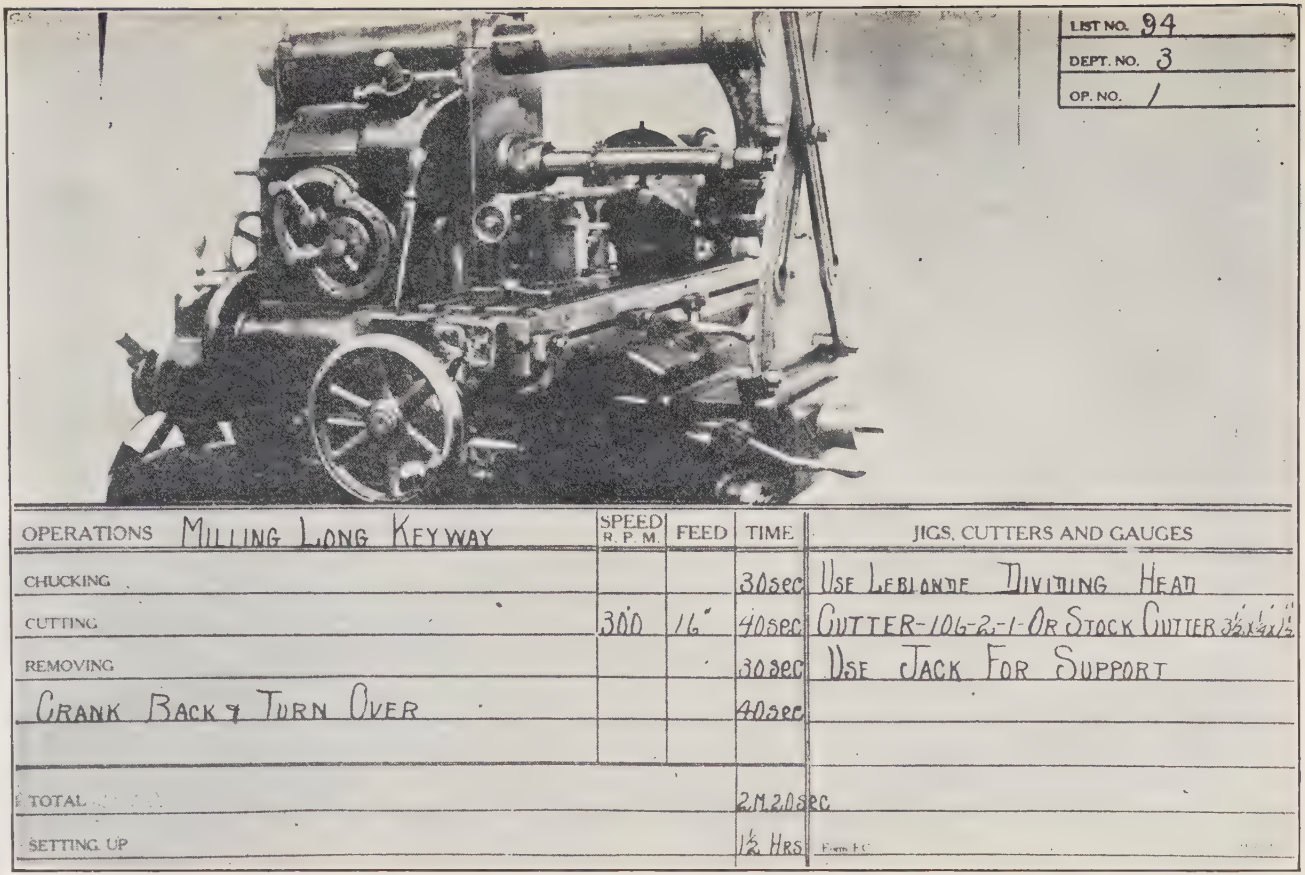
100% TIME ALLOWED

#40 DRILL IN FIRST SPINDLE FROM LEFT HAND SIDE.
#48 DRILL IN SECOND SPINDLE FROM LEFT HAND SIDE.
#9 DRILL IN THIRD SPINDLE FROM LEFT HAND SIDE.

SET UP OTHERWISE NOT STANDARDIZED.
SUPERVISOR OR SET UP MAN WILL SEE THAT ALL TOOLS, GAUGES, PANS FOR FINISHED WORK, SUPPLY OF LUBRICANT AND OF UNFINISHED WORK ARE ON HAND: THAT SET UP IS CORRECTLY MADE AND WILL TURN OUT THE CORRECT STANDARD OF QUALITY, BEFORE AN OPERATOR IS ASSIGNED TO THE JOB.

TOTAL TIME ALLOWED

Note Regular hourly rate will be paid for setting up emergency machines. Supervisors are responsible for the accuracy of all set ups and must approve samples of work from each set up. [illegible] set up job will be considered completed.



LIST NO. 94
DEPT. NO. 3
OP. NO. 1

OPERATIONS Milling Long Keyway	SPEED R.P.M.	FEED	TIME	JIGS, CUTTERS AND GAUGES
CHUCKING			30 sec	Use Leblonde Dividing Head
CUTTING	300	16"	40 sec	Cutter-106-2-1-Or Stock Cutter 3½x½x1½
REMOVING			30 sec	Use Jack For Support
Crank Back & Turn Over			40 sec	
TOTAL			2M.20 sec	
SETTING UP			1½ Hrs	From F.C.

Fig. 58.—Instruction Card with Photostat of Set-up, Jones & Lamson Machine Co., Springfield, Vt.

will in short order direct the attention of the observer to the causes of the workman's inability to make his task. For instance, if it should be found that the elements which were entirely handling time were being performed well within the selected element time, while the elements which were entirely machine time were running uniformly larger than the selected time, it would quickly indicate that there was something wrong with the equipment or the method by which it was being used. At any rate the production study will clearly reveal whether the particular operator is unable to reach the time that has been set because of the conditions of the time or the conditions of the job, including himself. It may reveal the fact that he is leaving his machine more frequently than is necessary, that he lacks skill, or that the handling time and the time for the adjustment of the machine are unduly large, or it may reveal the poor condition of the equipment, in case that be the difficulty. The value of the production study cannot be over-estimated. It is the means of rectifying errors in time study, and keeping the rates that are set uniformly correct throughout the shop, and therefore keeping the attitude of the workmen toward the management uniformly good as far as the setting of task times is concerned.

Production studies deal primarily with delays and their causes, whereas time studies ordinarily deal with the proper times for performing elements of operations, and although they are concerned with delays, these are merely incidental. It will be well to point out one class of time study that, in its original form, is similar to a production study. This class includes all time studies on automatic machinery. Automatic machinery, when once started, is supposed to continue in operation until the supply of raw material which is fed into the machine is exhausted. On many such machines provision is made for the continuous supply of material, so that there is supposedly no cause for the stoppage of this machinery during working hours. It would seem futile to take time studies on this type of machinery or operations involving its use. As a matter of fact, such operations are among those of which it is most profitable to take time studies, and where the results achieved in proportion to the energy which is expended are likely to be large. In taking time studies of this type of jobs, the study takes the form of finding out the causes for delay rather than finding out what the time of various elements should be. The times for the elements are involved in the continuous operation of the machine, which is usually an engineering rather than a management problem, as the machine will ordinarily be run up to the maximum possible speed, in order that the maximum production may be secured.

It is impossible to operate automatic presses, screw-cutting machines, looms, or any other type of automatic machinery without interruptions. On the other hand, the ability to cut down on the number of interruptions

will often determine whether or not the operation of the machine will prove most profitable. Small automatic screw-machine shops have often proved gold mines to their owners. On the other hand, similar shops have proved to be white elephants on the hands of other owners. The difference largely lies in whether or not the machines have been kept producing throughout the working day. In all automatic machinery, tools become dull or require changing, the material supply may run low, or there may be a number of other causes for stoppages. A time study of such machinery involves taking a production study for a period of a day or more, to determine which of these stoppages are avoidable and which are unavoidable. When this information is at hand it is possible to set a rate of stoppages which will apply to that machine at all times when working on the class of work studied. This will enable the shop to set tasks on the automatic machines which will be entirely within reach, in the same way that they may be set on any other machines in the shop. The setting of the tasks merely involves taking the capacity of the machine and deducting the allowance which has been found to be necessary by the production study that has been made.

In all time studies, but particularly in the taking of production studies, it is clearly evident that the high standard which was set up for the observer must be lived up to, if results are to be secured from the study. The powers of analysis of the observer include the ability to recognize facts as such, by separating them from attendant circumstances and from opinion. Initiative, ingenuity, energy, and imagination are all essential for originating ways and means of making the necessary separation of facts from theories, and the means of testing the reliability of supposed facts. The task-setter must be able to combine results and make deductions from his investigations. It is of small use for him to be able to separate if he cannot also build up and construct, of separate parts, a finished whole. He should be able to see clearly what the results of his minute study indicate, but he must at the same time be able to recognize the limits of the application of the facts deduced.

CHAPTER XXII

THE OBJECTIONS OF LABOR TO TIME STUDY

In the development of time-study work is frequently found the point of greatest friction between management and workers. Many workers, particularly many workers' organizations, have uniformly opposed the studying of jobs and particularly the setting of rates on the basis of time study. It is a peculiar, although partially explainable, fact that time studies are either looked upon with great favor or with great disfavor by the workers in plants where they have been attempted. In some organizations there is no tendency on the part of the workers to question the taking of time studies, or the times or rates which are set with them as a basis. In such organizations the time-study department usually has full and complete co-operation of all the workers. Those who are working on jobs which have not as yet been studied are anxious to secure the benefits resulting from the study. In other organizations, whenever any of the production executives walk through a department, there appears to be a general slacking up of work for fear that someone will discover just how fast the work can be done.

These differences in the workers' reactions may be ordinarily traced to the general confidence which they have in the management of the plant. It is not only true of time study, but of most other phases of management, that the best success will be had in those organizations wherein the workers have the most confidence in the management. From the description of the approved methods of taking time studies, it may readily be seen that a great deal is in reality dependent upon the general attitude of the management. If the management be broad and open-hearted it is probable that the task times will be readily achieved. If the management be close-fisted it is probable that time studies can be utilized in a way detrimental to the workers. Thus it is possible to find such great variance of opinion upon the part of workers toward the idea of time study.

Most of the objections that labor holds or has held toward time study are justifiable. In cases where the management wishes to make them so, they are unjustifiable, providing the management pursues a broad policy in its utilization of time-study data.

The objections held by organized labor against time studies crystallized in its opposition to the utilization of these studies in Government work,

particularly in the various arsenals of the War Department. Some of the earliest and best time-study work in this country was done in these arsenals, which caused various organizations, who were opposed to time study, to fear the effect of these examples upon the industrial community. After several trials they succeeded in having an amendment introduced to the appropriation bill before Congress, in 1916, prohibiting the expenditure of any funds granted by that bill to Government establishments wherein time-study work was allowed. The hearings before the House committee which considered this amendment clearly set forth the opposition of various members of the labor group to time study. Labor organizers, and those who were not working directly under rates set by time study, seemed in the main opposed to the idea. Workers in the Government establishments in question seemed, in the main, in favor of the time study and glad of the opportunity to earn the additional wages made possible through its operation.

Notwithstanding what has seemed to many to be convincing proof of the desirability of the utilization of time studies in Government work, the amendment was allowed to become a portion of the bill, and was the beginning of the end of time-study work in Government establishments. If the thought was that this blow to time study would successfully eliminate it as a major factor in the operations of industry, the action of the lobbyists who promoted the bill was in vain. The industrial community is utilizing time study and securing its benefit in many times the proportion that it was utilized in 1916. It is also securing a greater proportional benefit, due to a clearer understanding of the purposes of time study, to a betterment of the technique, and to a broader interpretation of its results by management. The almost solid front of labor organizations against the idea has been slowly breaking down within recent years. There are certain cases, as in the men's garment trade in Baltimore and the women's garment trade in Cleveland, where unions have actually acquiesced in time-study work as a means of setting standards for wage-payment. There are numerous other cases, among which one of the best known and most discussed is that of the Plimpton Press, in Norwood, Mass., where unions have worked with individual employers in the taking of time studies. Most important, there are still larger numbers of cases where union workers in plants where time studies are being taken are raising no objection to the taking of these studies. Union opposition to time-study work is rapidly declining, but is still a factor which merits consideration.

Classification of labor's objections. The objections of labor to time study may be classified under these main headings: objections to its effect on the status of the individual workers; objections based on its effect on some of the policies of trade unionism; and objections based on the defects

in time study itself. While many of these objections do not seem to be valid against properly conceived time studies, they are valid against time studies as practiced in those plants where the basic policy in the management has not been a broad one. A study of them will, at least, clearly indicate pitfalls to be avoided, and methods which may be utilized to aid in securing co-operation of workers in the taking of the studies.

Effect on status of individual workers. It has been pointed out by many workers that to take time studies of a worker is, in a sense, an evidence that management is suspicious of the fair intentions of the worker to turn out a fair day's work. It is explained that management would never think of taking time studies of executives in the performance of their jobs, but that more opportunity is usually afforded for bettering their output than for bettering the output of the worker. As in the case of most other objections, the only possible answer to this depends on the methods of taking the study, the extent of co-operation of the worker himself, and the benefits which the worker achieves.

It is also pointed out that time study is destructive of the worker's skill, inasmuch as it substitutes the skill of the management for the acquired trade skill of the worker. Not only may this result in the degradation of the worker, but it is to be questioned whether it is desirable from the broad social standpoint to allow one small class in the industrial community to have all the knowledge concerning how jobs should be done. In this connection, job study is frequently referred to as a means of making the worker a portion of the machine, that portion which has not as yet been cast into steel, and thus repressing his initiative. It is pointed out that after job studies, workers must conform to the methods of others.

Labor organizations have frequently pointed out that the pace which results from the taking of job studies may be destructive of the worker's health, in that it extracts his last ounce of energy and reduces his vitality. The fact that individual workers may be favorable to working under job studies, it is pointed out, does not necessarily mean that it is for their individual good. They may be thinking only of the pay envelope of the week or of the month, whereas it is desirable that somebody should be thinking of their future in the industrial community, and considering what their general vitality will be after some years of working under the pace which has been set. One of the strongest points in this connection is the method utilized in setting fatigue allowances in many organizations. To clearly overcome this objection to time study, it is essential that some definite attempt be made to study fatigue as applied to the jobs in a given shop, and to insure that the fatigue allowance is large enough to cover cumulative fatigue over a period of years.

It has frequently been said that, although rates under job study may be guaranteed, nevertheless time study becomes a method of cutting

wages. The reasoning is that the reservation is always made, in guaranteeing wage rates, that a change in the method of operation may result in a change in the rate. Since the method is so clearly and closely detailed by the result of job study, it becomes exceedingly simple in some slight degree to change the operation. This change may be brought about because of the high wages which workers may have been getting through close application to their work under the assurance that rates will not be cut; but the operation is slightly changed and the new rate which is set may be sufficiently below the old rate to make it necessary for the worker to apply himself at the pace he has achieved and, at the same time, to get wages which are considerably lower. Again, the only answer which can be made to this objection is that no management that wished to continue job studies over a long period of time, or wished to maintain good relations with its employees, would ever attempt any such practice.

The objections which have been noted may all be included under the heading of the effect of time study upon the individual worker. They have been, in fact, very largely caused by the second main type of objections, namely, the effect of time study on the policies of trade unionism. Were it not for its effect on these policies, it is not likely that some of the other objections would have been pressed as they have been on some occasions.

Time study is opposed to fundamental policies of trade unionism. Trade unionism is, of course, based on the idea of the development of class consciousness among workers as a group. This is necessary in order to combat the superior economic position of employers, particularly organized employers. Time study, which results, to an extent, in competition between the abilities of individual workers, naturally has a tendency to break down this class consciousness. This is particularly true inasmuch as the rates based on time study ordinarily are piece rates or some variation of these. Most unions have not been very favorable toward piece rates.

It is probably true that a study of jobs within an organization has a tendency to knit the organization into a unified whole of management and workers, all striving to better the general condition of a particular plant rather than any particular group in industry as a whole. In so far as this is true, it is but natural that organized labor should look with some degree of alarm upon time studies, particularly since this violates one of the basic ideas behind the development of unions.

The second of the causes of organized labor's objections to time study is based on its effect upon limitation of output. Most unions in the United States have not consciously favored the idea of limitation of output in the way that labor organizations in Great Britain have. But, expressed or not, it is evident from the attitude taken upon specific

questions, that a large share of organized labor in the United States has felt that the greatest good for the greatest number demanded limitation of output by individuals. Of course, the whole idea of job study is basically opposed to any such programme, and in so far as organized labor's programme has favored the limitation of output, it is only natural that it should object to the development of job-study work.

Objections to the time-study method. The third type of objections of labor deals with defects in the method itself. It is only necessary to state this because these defects must be frankly admitted in many cases, and the only question is whether, despite these defects, the advantages of job studies are not sufficient to justify their existence. Again, the extent to which these defects are important is largely dependent upon the general attitude of the responsible management of the organization.

Briefly stated, some of the objections based on defects in method are as follows: Since time study is so dependent on the ideals of management and of the observer, it is unwise for labor to lay itself open to the possible results which may follow. Although a particular observer or a particular management may be, at a given time, broad in spirit and in action, nevertheless it can never be known when the management will change, either in personnel or in spirit, and the results of the job studies may be used as a club over the worker, rather than as an aid to him. Again, the results of time study will vary in accordance with the degree of standardization which has been achieved. This relates not only to standardization of materials and machines, but to the weather conditions at the time that the study was taken. It cannot be expected that the worker will continue the year around at a pace at which he may have been timed under the best possible weather conditions. The manner in which he is allowed to work is also an important variable, and, although it may be presumed, under the best methods of taking time study, that the observer will be careful to insure that the worker does not reach a pace which cannot be maintained over long periods, nevertheless there is no assurance of this. This is particularly important in cases where a number of workers are engaged on one operation and only one worker is studied. Finally, methods of working up time study at best are arbitrary. The elimination of abnormal times, the determination of selected times, and the setting of allowances are all wholly at the discretion of the management. The worker who is being observed has no control over these whatsoever, and no worker in the plant has any control over these. Inasmuch as the final task set, and hence the wage rate, is more directly dependent upon these than it is on the observations which were taken, it follows that co-operation of the workers in the taking of time study becomes merely a pleasant fiction.

The ways in which many organizations have developed their time-study work and utilized their time-study data have gone far to justify the

labor criticisms of time study. Unfortunately, many of the first plants to use time study were those who merely saw in the idea a method of securing greater output from the workers. Thus this very important aid to the development of modern management early fell into disfavor, not only among the labor group, but among many other portions of the community.

It is only by careful utilization of the potentialities of time study that this early attitude has, in a sense, been overcome and that the objections which have been set forth above are being heard less frequently. The continuation of time study and of job study, in general, in the industrial community of the United States, depends entirely on its method of utilization by those who are in a position to cause either its more general adoption or its necessary elimination. Year by year, more industrial concerns are utilizing it more intelligently, and it is gradually taking its place as an essential factor in the intelligent operation of any industrial plant.

PART VI

WAGE PAYMENT

CHAPTER XXIII

THE BASIS OF INDUSTRIAL WAGES

Basic wages must be right. The most important employer-employee relationship is that of wage payment. All other phases of their relations rest squarely on the payment of what seems to be an adequate wage. The dollar sign is the universal countersign in the industrial world. It is the best key with which to open the door of production or industrial peace. If wages are "right," many steps toward the betterment of employer-employee relations may be advantageously taken. These steps cannot be taken if contentment wages are not paid.

The reasons behind this most important position of wage payment in industrial management are readily apparent when the effect of the setting of the wage upon the life of the worker is considered. Ordinarily, the scale of living of the worker is, at any time, directly dependent upon the wage which he is receiving and its purchasing power. He, ordinarily, has no accumulated surplus upon which he can draw and no other sources of income besides his daily wage. Therefore, the wage that is paid places or lifts restrictions on the home life and recreation of the worker, and reaches into his home life in a way unknown to any other management factor.

All of this has brought most factory managements to a realization that wages are the most important power factor in the shop. Let us return to the idea which was used in connection with the development of modern industrial organization, namely, the idea of comparing such an organization to the modern power plant development which is flung across a stream. Wages may be looked upon as the inherent source of power which makes the turbine representing the organization revolve. The more wages are paid, the faster the organization will move toward the desired goal. The less of wage, or inherent power, that is allowed to

flow through the organization, the less developed power may be expected as a return. But the utilization of this great power force is not simple. Wages paid cannot be considered in the absolute, but must be considered relatively to those paid by other concerns in the same field of business, or in the same community.

Relation of the method of wage payment to the wage problem. Furthermore, the method of payment must be considered. In a power plant, the angle at which the water impinges on the blades of the turbine is an extremely important factor in its efficiency of operation. Likewise, in the utilization of this industrial force, the method of application of the force to the organization is an extremely important factor. Especially designed wage-payment systems may be utilized to so develop the inherent force of the wages paid, as to secure the maximum results. This, then, is the relation which exists between a particular method of wage payment and the wages problem in general.

The satisfactory wage. No particular method of wage payment will succeed unless the basic wage is right. There is no spurring action in the development of a bonus system where the bonus is, in fact, merely a portion of what elsewhere would be a basic wage. The determination of the basic wage is thus the most important consideration in wage payment. The determination of the amount of wages paid under our industrial system rests primarily with the employer, but it nevertheless must be satisfactory to the employee, and is limited by its acceptability to the employee individually and collectively, at times by the general attitude of the community, and possibly by some state action. Thus, instead of a basic wage which is set entirely by the employer, there is found a basic wage which is ordinarily termed "right" or "satisfactory." There can be no general definition of the meaning of a "satisfactory" wage, inasmuch as its limits will differ so greatly under varying conditions. However, it can be stated that a satisfactory wage must bear the scrutiny of employees and at times of the community. The general attitude of the community will not be likely to affect an individual plant except in cases where that plant is the main or basic industry of the community, or except in cases of localized industry where a large portion of the community, other than those who actually are at work in the plant, secure their livelihood as a result of the wages paid within the factory. In such instances as the Rhode Island textile strike of 1922, where a closely knit community is largely dependent on one type of industry for its existence, it is not surprising to find that wages or wage reductions, as in this specific example, must be acceptable to the community as a whole, as well as to the employees of individual organizations. State action, in the form of minimum-wage laws, has not largely influenced industrial wages in this country.

Not infrequently we hear satisfactory wages being spoken of as though

they were just wages. In order to indicate the inaccuracy of such an idea and also to prevent wonderment when a so-called "just" wage is attacked by the employees, it will be well to examine the fundamentals of of what constitute "just" wages.

What are just wages? Any true idea of just wages must necessarily include a concept of payment to wage-earners on the basis of their contribution to industry, as well as some concept concerning the right to a fair living of an individual engaged in the productive process. The contribution of an individual or, in other words, his "productivity" has never satisfactorily been measured under our present industrial system, and it is questionable whether it can be measured. Our whole life is so complex, and the relations of one person to production are so inexact, that it becomes practically impossible to determine the extent to which he or she has added to the goods of the world. Prior to the factory system, it was more possible to arrive at some concept of the productivity of an individual, but the factory worker of to-day is performing but a very small part of the production of the article on which he is working. The machine on which he works and the building in which he works have not only been furnished and designed by the employer and the management, but have, in the first instance, been created by other factory workers. A knitter working on a complex knitting machine contributes much to production of the finished product which comes off of that machine. The question remains, how much of the production is made possible by the workers in another factory far removed, who made the knitting machine. These other workers were engaged in the production of machinery because of the capital and foresight of those who founded and operated that enterprise. Probably parts of the machine were made by still other workers in another plant working under similar conditions. How much of the product of industry belongs to each of these workers? How much actually belongs to each of the employers, to each of the managements, or to the salesmen who are selling the machinery, or the finished knitted product? That is the question which must be decided if an attempt is made to develop a just wage based on productivity. It becomes immediately apparent that this is practically an impossible task, and our idea of justice must be tempered by other considerations.

Presumably, regardless of the productivity of the individual, there is a point below which wages must not go, in order that the individual and the persons dependent on him may survive. This is seemingly the lower limit of a just wage but, in particular cases, even this lower limit must presumably be cut under if, for the moment, the industrial establishment in question is to survive. In view of these considerations, it becomes apparent that it is desirable to temper judgment concerning the justice of a wage. However, there are certain ways in which a given wage may be

regarded by those intimately concerned with it which aid in determining whether or not that wage approaches a just wage. Probably that is as far as anyone can go at the present time.

Measurements which aid in considering the justice of a wage. There are two measurements which aid in the determination of this approach to justice. The first is that the wage must represent the results of a convincing effort to divide the product of industry on a fair basis. The wage which is paid because the employment manager calls up a manufacturers' association on the telephone to find out from the secretary what " is being paid for a given class of job " at a given time does not represent any such effort. On the other hand, many organizations have wrestled with the problem and have come to conclusions which indicate that justice is being approached.

The second measurement is that the wage must command the support of all groups connected with the industry and the support of the community at large. If this is the case, it may be presumed that the wage is approaching a just wage. However, because of all the factors which have been described, it is better to think of the proper basic wage in industrial plants as being a satisfactory wage rather than as being a just wage.

The bases of satisfactory wages. There have been set forth three main bases as those which determine the satisfactory wage. Certain individuals have pointed to each of these as being the true base which sets the wage. These are supply and demand, the cost of living, and individual productive capacity. It is probable that in most instances all three aid in the determination of the basic wage rate, but no single one alone sets the rate. Supply of and demand for a given type of labor unquestionably have a large influence on the wage paid in most plants at any given time. With this fact in mind, both employers' and workers' organizations attempt to influence the supply of labor in the direction of their interest. Thus the spoken and written word of many employers indicates that they feel that there must be a pool of unemployed in order to bring the best results for industry, and that when the worker population in this pool becomes small, steps should be taken to increase it promptly. The attitude of many employers to the immigration problem is indicative of this. The workers, through organized labor and its attendant policies of the closed shop, restriction of apprentices, restriction of output, and elimination of overtime work, have conversely sought to limit the supply of workers. As either the employer or the employee gains the upper hand in connection with demand and supply for workers, wage rates are seen to fluctuate.

Thus, wage rates are frequently set largely on the basis of what the worker can be secured for, that is, what he can get elsewhere. Large organizations having plants in different cities pay different wages in each

plant for the same work, depending upon what the wage levels in these communities are. Some companies, which operate largely on this basis, at times have different rates for the same job within one plant. For instance, in some of the glass plants of southern New Jersey where the supply of boys as helpers has frequently been the limiting factor in production, the man with the most boys has at times commanded the highest pay for his own labor. Factories which use supply and demand as the main or only basis for payment of wages usually are the first to decrease their wages in times of depression, and the first to be forced to raise their wages in times of increasing prosperity. Base wage rates which are set entirely on this policy imply fundamentally a policy of drift.

Cost of living as a factor in wage payment. The cost of living has gained increasing attention as a means of fixing base wages. The idea involves a decrease or increase in the basic wage dependent on the rise or fall of commodity prices and other factors which influence the budgets of individual workers. Cost of living statistics have been collected on an increasingly large scale and have been used by an increasingly large number of organizations which are attempting to set satisfactory wage levels within their plants. Although cost-of-living figures are extremely satisfactory as a check on base rates, nevertheless one of the most unsatisfactory features of them is that they are ordinarily based on the " average family." This usually consists of a man and wife and two or three children. The position of the single man, or the man with seven children, is thus thrown into question, if these cost-of-living figures are extensively utilized. A number of plants utilize figures of the Bureau of Labor Statistics, Department of Labor, of the United States Government. Other plants use state figures, while other concerns have made attempts at the collection of figures which relate more specifically to their own problems. In this latter class may be mentioned the plant of the H. H. Franklin Manufacturing Company at Syracuse, N. Y., which has, for some years, collected cost-of-living statistics in the city of Syracuse at intervals; and the plant of the Index Visible Company at New Haven, Conn., which has for some time collected cost-of-living statistics on a weekly basis, and has made prompt changes in base rates to meet changes evidenced by these figures.

The fundamental difficulty with the cost of living as the basis for setting industrial wages lies in the definition of the term " living." What is the difference between the idea of " cost of living " and that of " scale of living "? Habits, custom, and environment all influence an individual's idea of what constitutes the cost of living. The American worker of to-day views as necessities many items which are regarded as luxuries by European workers, and were entirely out of reach of all except a few of the nobility prior to the development of the factory system. Any thought of cost of living must necessarily imply the idea of the development of an increas-

ingly better scale of living, if the United States is to progress, and if the industrial system as at present constituted is to endure.

Productive capacity as a basis for wages. Individual productive capacity cannot serve wholly as the basis for setting wage levels. It can be viewed as a partial aid in setting relative wage rates, and all of the work in job study and in the development of particular wage-payment systems which has been lately carried on in industry has this in view. If a sales manager is to be employed, it is to be presumed that he will be paid at a higher rate than a laborer in the shop. This is not entirely due to supply and demand, but is partly due to the concept of individual productive capacity. This factor, therefore, influences very largely all wage rates which are set, but any thought that it governs them entirely will come back to the idea that the exact contribution of wage-earners can be measured. It has been demonstrated that this is difficult, if not impossible. The influence of individual productive capacity is felt on original rates granted members of a working force, but has greater influence on changes which are made in these rates after employment. Many wage systems have been developed with the thought that individual productive capacity can be measured, and the defects in this reasoning must be considered before approval is given to any such system.

Payment of wages above the community level. Many plants have entirely given up the idea of determining exactly what the basic wage should be, and have fallen in with the thought that the greater the wages which can be given to the employees, the more will be the inherent power provided in the organization. The signal success of the Ford Motor Company in its relationships with its employees has been very largely based on the payment of a wage which is higher than the community standard. The proved success of the relationships established between men and management in the Philadelphia Rapid Transit Company has as its basis the thought of the payment of a contentment wage which is higher than similar types of workers receive within the community. Thus motormen in this company receive a wage which is essentially that of skilled mechanics in the community. Unit operating costs of this company are far below those of similar traction lines, and it is common knowledge that the production costs of the Ford Motor Company are below those of competing automobile concerns, despite the higher wages paid. That high wages do not necessarily mean high labor costs, but, properly utilized, many mean low labor costs, is well understood by the modern school of industrial managers. Therefore, the determination of the economic basis of setting wages becomes less important as a manager attempts to set wages on a level which is higher than paid corresponding workers in the community. The basis of most modern management steps involves the payment of higher wages than would be paid under the

older type of management. This higher wage is returned through a lowering of overhead costs, due to increased production and other benefits that are secured by means of complete co-operation between the management and the workers. If this be kept in mind, together with the importance of wages as a factor in industrial management, the question of exactly how wage levels should be set decreases in importance.

The sliding scale. The sliding-scale idea in wage payments involves the idea of arranging in advance reductions in rates when competitive conditions in the trade make these desirable, and increases in rates that will enable workers to share with the employer the benefits of times of prosperity. Under this scheme a basic rate is fixed to correspond with a determined selling price of some finished product of the industry, and then with fluctuations of the selling prices, rates will drop or advance a predetermined amount. This method of wage payment is in little use in the United States, although it is used considerably more in Europe, particularly in England. It generally works to best advantage in negotiations between bodies of employers and unions, since it involves the acceptance of the plan on the part of employees, which is difficult to obtain except where they are organized. However, the recent development of the movement toward works councils has increased the possibility of handling this system as a one-company affair. In such cases its workings are likely to be somewhat less formal, and to represent merely the enacting of community sentiment that wages should increase in times of prosperity and must be reduced in times of falling prices.

A formal sliding scale, adopted in advance, will not succeed where the commodity being manufactured does not have a wide, competitive market, with open quotations on current selling prices. Thus the sliding scale may easily be introduced into the manufacture of pig-iron because quotations on finished pig-iron are easily ascertainable. It may be introduced into cotton-spinning, because its fluctuations may readily be based on the selling price of a particular grade of cotton yarn. It is not applicable to a specialty business.

The method of determining the way the scale of pay shall fluctuate with the scale of selling prices is a matter for bargaining, but ordinarily the increase or decrease of the wage should bear approximately the same relationship to the increase or decrease of the selling price that wages bear to cost of production in the particular industry or plant.

CHAPTER XXIV

THE DAY RATE AND THE PIECE RATE

A STUDY of wage-payment plans follows naturally a discussion of job study and analysis, and the basis of industrial wages. From what has been said of the basis of wages it is evident that any discussion of wage systems may be handled from several points of view. For instance, it may be developed entirely from the point of view of the employer, entirely from the point of view of the worker, or from the point of view of the community at large.

The consideration of wage-payment systems which follows discusses these systems from the standpoint of management in industry, that is, securing the greatest possible production from the worker compatible with his health and fullest co-operation. In considering these wage-payment systems it will always be well to keep in mind the requirements of the cost-accounting department of the business as well as of the production and general management forces. Systems which involve the collection of a multiplicity of data may conceivably succeed in increasing output and thus decreasing the unit cost of production, but fail because of the excessive cost and difficulty of collection of data for payroll and cost purposes.

The day rate. The payment of a certain amount to a worker for a certain period of time is usually known as a "day rate," regardless of whether the period of time be a day, a week, or an hour. The day rate is perhaps the oldest method of wage payment under our present industrial system, and probably more than half of the industrial workers of the United States are to-day being paid under some form of the day rate. Unless the worker be so inefficient as to merit discharge, or unless he be so expert as to be raised into a higher wage classification, it is unlikely that his individual rate will be changed. Thus the amount or quality of work which he does has little bearing on the wage which he receives, except over long periods of time. There is, under this system of payment, little to urge a worker toward greater production except loyalty toward his task or some spurring action on the part of his employer, or management's representative, the foreman.

Under older management methods the use of the day rate ordinarily resulted in closer administrative supervision by the employer. Increased production by a worker under this system implies directly increased

profits. Decreased production brings with it monetary loss which comes directly from the pockets of the employer. Therefore, along with the day rate has ordinarily come careful attention to mechanisms that will increase production. It was an ideal system for an era of attention to the mechanics of production.

Many workers have favored the day rate, because under it they could definitely determine in advance what their wage would be. That all workers of a given class generally receive the same pay constitutes no objection for these workers. In fact they tend to favor it, because it implies a unity of action, through organization, of all members of the wage group, in case it seems possible to secure an increase of the rate. For these reasons, day rates, once raised, are frequently as difficult to lower as any other kind.

In the main, labor unions have tended to favor the day-rate system. Unions exist for the benefit of their membership as a whole, and therefore anything which will tend to increase the unity of purpose of their members is likely to engage their support. The day rate is a perpetual influence toward solidarity in the union Substandard workers look to it as a means of raising their wage far beyond anything they could expect under piece rates. The average worker is likely to be satisfied with the prevailing wage. The best workers are likely to be constantly striving to increase their income, and in doing so will tend to increase, along with their own income, that of the other members of the labor organization. As a matter of fact, the best workers who, under other systems of payment, are least likely to be interested in unions, under the day rate are likely to be the prime movers toward organization. It is their only hope for increased wages. Thus they frequently begin to combat the management, whereas they may be easily made the management's strongest supporters.

Quality of product should be enhanced through the day rate. The workman, not being rushed, should be able to fully utilize his talent in those tasks where such expression is possible. Plants or departments in which quality is a paramount consideration are thus most likely to be on day rates. Nevertheless, effective foremanship and newer methods of wage payment make possible high quality production without the day rate.

Pay-roll department operation is made simple by the day rate. The pay-roll may be prepared directly from the attendance time cards. On the other hand, cost department operation is made more difficult. Production will vary greatly from man to man and from day to day under this system, and wages thus become a variable element of cost which cannot be predetermined. Thus, to plan production cost budgets and selling prices becomes difficult.

Perhaps the chief objection to the day-rate system is that it is no inspiration to any worker, good, bad, or indifferent, unless the urge toward

quality be so considered. Utilization of the day rate is likely to bring with it the attitude that a certain amount of time must be put in between whistles, and that mere presence is all that is implied under the wage contract. Such vicious economic ideas as limitation of production are caused to develop through the utilization of the day rate of payment. There is enough leveling of workers and lack of opportunity for growth to commanding positions under the necessities of our industrial system, without unduly adding to it through the influence of a method of wage payment.

Regardless of the type of wage-payment system that may be in vogue, it is usually necessary to pay a certain percentage of the workmen by the day rate. This group of workmen will not only include supervisors, but any men whose work is so diversified, incapable of standardization, or temporary, as to make it impossible to work out a satisfactory wage under any other system of payment. Because of its ease of operation the day rate will probably continue to be much used as a system of wage payment.

The straight piece rate without job study. The second of the older plans of paying workers is to fix a price for the completion of a given task, and pay that price without reference to the time taken in completing the task. The task may be either the completion of one unit or of a given amount of work, and the rate is ordinarily termed a piece rate. Piece rates have usually been set with strict regard to previous day-rate earnings and previous performance. They have usually been determined by dividing the day rate by the average units of production, in order to secure the proper rate per unit. Sometimes the rate has been made somewhat less than this amount, under the assumption that production will increase under piece rates and that this will bring greater profits to the employer. But usually the employer has been willing, at the start, to profit only through the reduction in his fixed overhead expenses per unit of product. Since these expenses remain approximately the same and with greater production are distributed over more units, there should be profit to both employer and worker through such increased production. If a worker should be so poor as not to reach average production, his wage under the piece rate would be less than under the day rate, thus bringing a saving in direct wages in the case of substandard workers.

First-class workers handling repetitive work have usually been anxious to be placed upon piece work, inasmuch as it gives them an opportunity to realize on their accumulated skill and knowledge of the job. The direct monetary gain which results from study of the method of performing the job by the worker is likely to result, not only in his keen study of conditions which surround it, but, within limits, in his becoming receptive to improvements in methods promulgated by the management. He is not

receptive to such improvements when he is fearful that they will be so marked as to result in cutting of the rate. Substandard workers and those working on diversified work on which the setting of piece rates based on past performance is difficult are not likely to favor piece rates. Workers generally fear that the management, in setting rates on jobs where there is no accumulated mass of information concerning past performances, will protect themselves by making the rates so low that the worker will be unable to " make out," or earn the equivalent of the day wage.

The greatest defect in the piece rate in practice is one that in theory need not exist. That is the tendency toward rate-cutting. Although the employer is receiving benefits in reduced overhead charges, he is not likely to long allow workers to " kill " a job, that is, to get wages which are far in excess of the usual rate of wages for such work. Either the press of competition, the desire for increased profits, or both, is likely to cause him to demand that the management cut the rates. Frequently this has been done under the assumption that if the workers do not like the change they can readily be replaced at the new rates. The action of rate-cutting is equivalent to informing the employees that there is a maximum of earnings beyond which workers of any general class will not be permitted to go. Such action, once taken in an organization, or fear of such action based on practices in other organizations, causes workers to hold their production under piece rates at the easily reachable figure which it is thought the employer has set as his maximum. If rates have once been cut, this figure will at times, through a shop, be so uniform as to amount almost to an exact limit. Unfortunately, there is no possibility of making clear to all concerned what the exact conditions surrounding a job set on the basis of past performance are. Really radical changes in production method, which so change the job as to make the past rate absurd, have been frequently looked upon by workers merely as an excuse for cutting rates. Changes in method have at times been bitterly fought by workers for fear that under the new method and new rate they would be unable to make as high piece-rate earnings as under the old method. This confusion between logical piece-rate readjustments and rate-cutting results in numberless borderline cases which it is difficult to amicably settle, because there are no real data, convincing to both sides, which may be used as a basis.

Some executives, when pegging of production at a relatively low level has been pointed out to them, have indicated that this did not seem to them to be an objection to piece rates. Inasmuch as the worker is only being paid for the work that he is turning out, why not allow him to loaf? Such ignorance of cost accounting as is implied by this attitude is happily passing, but it clearly indicates the necessity of a check on management

that will force it to better its methods. Such a check is not provided by piece rates. Piece rates set through the aid of time study have few of these objections and will be discussed later.

The general tendency of piece rates is toward quantity at the expense of quality, unless a very careful inspection system is installed. Furthermore, the tendency is toward overstrain and cumulative fatigue of the worker, if he is convinced that the management is not going to cut rates. Therefore, under piece rates, not only is careful inspection of the product necessary, but some sort of inspection of men is also desirable. Guaranteed piece rates are dangerous in factories operated by the ordinary type of management—dangerous to the worker and to the community. No definite knowledge of what a worker ought to do is usually at hand, and as a result over-strain becomes a probability.

If straight piece rates are used, it is essential that some provision be made for the learner. Inasmuch as there is no day rate guaranteed under piece-rate plans, it is necessary that a special " learner's rate " be established, which is usually on the day-rate basis. The length of time that the learner remains on day work varies with the type of operation and with the factory, as well as with the training system that the plant has installed. The learner's rate usually starts at a low point and gradually increases up to the point at which the worker is put on piece rate.

Piece rates have the disadvantage of being inflexible. Difficulty in the setting of piece rates is encountered when the whole level of rates paid workers rises and falls. If rates have been raised during periods of high wages, they are usually decreased during periods of depression and falling wages. Such lowering of wages is, of course, a cutting of the piece rate. This situation results in very perplexing problems which have been solved by some plants not by increasing piece rates, but rather by giving a " cost of living " bonus, or by placing the wages from an increased piece rate in a separate pay envelope, in case the rates were increased. If either of these plans were adopted during the times of higher wages, such as 1914–19, the plant had an easier time during the days of wage reductions, such as in 1920 and 1921.

In times of depression, when orders are scarce, the piece rate has a great advantage over day rates or any of the newer systems which guarantee minimum earnings to the worker. Under such conditions many plants are operating from hand to mouth on orders, and this is as well known to the workers as to the management. The piece rate is practically the only system of wage payment that does not invite the worker to stretch available work, so as to insure himself a job under such conditions. In prosperous times, with orders plentiful, this ceases to be an advantage of the piece rate.

From the cost-accounting and cost-estimating standpoints, piece rates

are far better than day rates, but not ideal, as contrasted to other systems. The direct labor cost per unit of product or per job becomes a fixed amount which may be accurately determined in advance. But, since the time of doing the work varies considerably, the amount of overhead expense which will have to be distributed to an operation or an order is an unknown quantity previous to actual performance.

CHAPTER XXV

INCENTIVE WAGE SYSTEMS

In meeting the objections to the older systems of wage payment and developing methods which will prove to be lasting improvements, attention must be paid not only to proper remuneration of the workers, but also proper remuneration of invested capital. Schemes can be devised which will prove entirely satisfactory to the worker but which will in time be eliminated by those controlling the enterprise because they will not be flexible enough to permit the meeting of increasing sales competition. Thus any wage scheme which gives the worker a percentage of the savings incident to increased production and yet prohibits innovations in manufacturing method or inclines to make the worker peg his production merely at a somewhat higher point than formerly, due to fear of ultimate wage-cutting, will not be beneficial for long. Rival plants, whose rates are set on the basis of newer manufacturing methods, or whose workers have not pegged production even at the relatively high level, will always be able to underbid, because of lower manufacturing costs. This is the basic reason behind changes of rates when the process or operation is changed. It is thus essential that any wage-payment system which is devised shall so arrange the remuneration that the permanent co-operation of both the workers and the stockholders' representatives shall be assured. No general rule can possibly be laid down concerning the method of arranging such remuneration which will apply to all cases. General lines of attack of the problem can be indicated, but these must be intelligently fitted to each individual situation.

In general, it may be definitely stated that unorganized workers like to work under one of the "incentive" wage systems when they are fully convinced of the fairness of the management and the fullness of information possessed by the actual rate-setters, as well as the competence of the latter. These systems plainly indicate to the workers that they are expected to perform up to their capacity, fatigue considered, while they are on duty in the factory. The older wage systems do not continually convey this information to the worker as do these newer systems. The day rate conveys to the minds of some workers that they are being paid for their mere presence within the factory walls, and under the piece rate it is frequently assumed by some workers that, since the management is only paying them

for the actual number of pieces that they produce, there is no particular desire on its part that they should reach any particular maximum during the day. Incentive wage systems awaken the interest and put the spirit of competition into industry. They make it practical to arouse interest in work to an extent that can be achieved in no other way.

An incentive wage, in order to be effective, must generously reward the worker for the additional application, following of instructions, increase in output, and quality of workmanship which is required in order that the additional wage shall be earned. Unless the reward for increased production is large enough the worker will not be stimulated to the increased production which is possible under such a wage system. It should be emphasized that cupidity on the part of management is like signing the death warrant of any of these incentive schemes of wage payment. If the reward is large enough the worker will be enabled to take new pride in his work, the pride of having earned more money this week than he did last, because he worked better and more effectively. The pride of accomplishment in relation to his fellow-worker develops. This is a perfectly logical and justifiable pride and does not necessarily result in the setting of a killing pace.

The schemes of wage payment which have been developed in recent years are about as numerous as the people who have been thinking about incentive wages. At least it is true that every industrial consultant seems to have worked out a wage system of his own, which he tries to demonstrate as being better than all which have gone before. In most cases, as far as fundamental difference goes, these particular schemes vary only sufficiently to allow them to be designated with the names of their authors. There are only a few fundamental ideas connected with these wage-payment methods, and it is these which we will consider. Of course, in the adaptation of these fundamental methods to the particular plant or department, there will have to be minor changes made.

Premium plans—the Halsey Premium System. All premium plans of wage payment aim to give the worker some share of the saving in the costs of production which are earned by turning out the work in better time than the task, standard, or normal time for the job. One of the most common of these systems is the Halsey Premium Plan, named after F. A. Halsey, who devised it at the time he was superintendent of the Rand Drill Co., of Sherbrooke, Canada. The basic idea of it is to set a standard time, usually by ascertaining the average previous time of doing the job, and to offer the workman an agreed percentage of the wages of any portion of this time that he may save, in addition to his hourly or daily rate for the time consumed on the job.

Although, as originally conceived and generally used, the standard time under this plan was the standard of past performance in the shop, there

is no reason why a standard time determined from time study cannot be used under the Halsey plan. However, since the Halsey plan gives the worker only a portion of his saving, if time study be used as the basis, it is essential to set the standard time somewhat higher than the time which can be made, in order to provide sufficient incentive for the worker. The task time set by job study thereby becomes a base for the management to work from rather than a task to be reached. However, under the Halsey plan, the standard time is usually the average of previously recorded times. It is usual to guarantee that when the time is once set for a job it will not be reduced, despite the fact that conditions may not have been standardized, or the jobs studied. The system is liberal with the time allowance rather than with the premium percentage.

Day rates are guaranteed under this plan, and to men who finish their tasks in less than the allotted time there is paid, in addition to this base day rate, a proportion ranging from one-quarter to one-half of the wages of the time saved. Thus the wage under the Halsey system is equal to the time taken, times the hourly rate, plus the time saved times some fraction of the hourly rate. The fraction of the hourly rate that is most generally used is about $33\frac{1}{3}$ per cent, in case conditions have not been standardized or the job studied. If the job has been studied, the fraction of the hourly rate that is used will ordinarily range around 50 per cent. The percentage of the time saved—from 30 to 50 per cent—is likely to represent a rather large part of the total wage, and to make the percentage larger would be apt to create a distinct temptation to the employer to reduce the standard time when shown that it was considerably longer than actually necessary.

To illustrate the working of this plan, we may consider the case of a workman who is on an hourly rate of 50 cents per hour, and has an eight-hour task given to him, which he completes in six hours, working with a bonus of $33\frac{1}{3}$ per cent of the saved time. He will receive:

$6 \times \$0.50 = \$3.00$, the hourly rate, and
$\frac{1}{3} \times 1.00 = .33$, the bonus
Total $= \$3.33$, for the job

It will be noted that he received \$3.33 per six hours' work, which is at the rate of $55\frac{1}{2}$ cents per hour, or at the rate of \$4.44 per day, providing his time on the next job which he may start immediately is as good as the time on this job.

The Halsey plan is easy to introduce. It is not absolutely necessary that there be preliminary studies, other than those which will determine previous times on the jobs, and the plan is therefore excellent in any shop as a sort of transition plan to be used while studies of the jobs in the shops are being made and to arouse the interest of the workmen in incentive

wage systems. This plan, in a slightly modified form, received its greatest amount of advertising from its use in the shops of the Yale & Towne Manufacturing Company. It was used as a transition plan in this case, since it has been largely supplanted by other incentive wage systems.

One of the chief merits that are urged for the Halsey plan is that it makes for the permanence of the rate because of the method of division of the profit on saved time between the employer and employee. If an extremely large time is allowed for one job, and as a result the workman makes a very large saving of time, only a portion of the saving is given to the workman, which prevents the employer from having an immediate desire to slash the rate. The plan is also very simple and not as confusing to the workman as some of the other plans. It is perfectly simple for any man, when he knows the standard time and the actual time, to subtract the actual from the standard, and then perform the simple calculation noted above.

If the Halsey, or any other premium plan, is used as a transition plan much care is needed to see that it is so arranged that wages under it will not be higher than wages are to be under the permanent plan adopted. With increased study of the job, it is possible that toward the end of the use of this plan in the transition period the worker may earn very high wages, wages which cannot possibly be maintained over a long-run period. Naturally the permanent plan will be looked upon as a method of cutting wages if the amount in the pay envelope at the end of the period is less than under the transition plan.

Since premium earnings often total a very large percentage of the total wages, the plan is criticized from the management point of view in that standard times prove in practice to be so very high that a temptation to reduce standard time in one way or another is sure to come eventually. And further, standard times are sure to be uneven in that some will be very high and some will be comparatively low, which results in an unjust payment plan with " fat " jobs and " lean " jobs. In such cases there will tend to grow up a picking and choosing of jobs among the workman, or criticism of the allotment of jobs among them, just as in any piece-rate plan where the piece rates are variable in their earning capacity. Furthermore, the workmen can beat the game by spurting on certain jobs to earn a premium, and soldiering on other jobs to rest up under the guarantee of day wages.

The Rowan Premium Plan. Another typical premium plan, which has received much attention, originated in a Scotch establishment, David Rowan & Sons of Glasgow, being developed by Mr. James Rowan of that firm. It is used more extensively in Great Britain than in this country, although several large American concerns, notably the Packard Motor Car Company, have adopted it in parts of their factories. Although a

premium plan, like the Halsey, it differs in the method of computing the premium and in the base used. Wages, instead of being increased by an arbitrary percentage, applicable to all similar jobs, are increased by a percentage equal to the percentage of reduction which the worker has made on the standard time of the particular job. This premium is a percentage of time worked, rather than of time saved.

If the time be cut 40 per cent, the premium is 40 per cent. Thus if a workman whose rate is 50 cents per hour finishes a ten-hour job in six hours, saving thereby 40 per cent of the time, he received the hourly rate for six hours, or $3, plus 40 per cent of this, or $1.20. This makes the job rate $4.20, or 70 cents per hour, which is at the rate of $5.60 per eight-hour day. It will be seen that ordinarily the premium is larger under the Rowan plan than under the Halsey plan. If the Halsey premium be $33\frac{1}{3}$ per cent, the Rowan premium will always be larger up to $66\frac{2}{3}$ per cent of time saved. If the Halsey premium be 50 per cent, the Rowan premium will be larger up to 50 per cent of time saved. Thus, in most cases, the Rowan premium is larger.

Although it is somewhat easier to justify the percentages used under the Rowan plan than those under the Halsey plan, nevertheless adaptations of the Rowan plan are far less used, chiefly because the method of figuring wages is too difficult, and the worker finds it hard to understand, and harder to know what he has earned at any given time. It involves the use of a large clerical force for pay-roll purposes and makes cost-predetermination almost impossible.

Incentive systems based on job study and the task idea. The incentive wage systems which follow are more suited to use with other phases of modern management than are those already described. They are developed from the standpoint of having the worker make the set task, rather than having him beat it. The premium systems reward the worker for beating the task, the following systems reward him directly or indirectly for making it.

In considering the following systems we are leaving behind those systems which are contented with the ordinary type of management and are considering those which squarely put the question of improvement in the methods of management up to the management. The Halsey and other similar premium plans may permit a policy of drift in management, which is prohibited by the use of any of this second group of incentive wage systems. If the management drifts, none of these wage systems will work. They are automatic checks on good management. It is necessary to vigorously control all conditions, to set the task with as much accuracy as is possible, and with these as bases to be careful not to withhold from the worker any portion of the advantage in time which he gains by the reduction of the working time below the task time. These systems make

the worker push the management quite as much as the management pushes the worker.

The higher rates which the workman earn under all of these systems must necessarily take into account the fact that the management, as well as the worker, has had a hand in the increased production which is being secured. The employer has given more of his thought and money for the installation of the new conditions under the operation of these wage systems than in the operation of the premium systems previously discussed. The employee, on the other hand, must give somewhat more concentration and possibly lose some of the pleasure which may be presumed to come from freedom to do the task in his own way. He should, therefore, be paid a larger bonus for accomplishment under the following incentive wage systems than under the previous ones.

Day rates based on production. The simplest incentive wages are those which are day rates fixed on the basis of the production of the individual. These are of two types, (1) a series of day rates based on productiveness, or (2) one high day rate based on a high standard of performance. The utilization of a series of day rates based on performance provides for the fixing of a number of classes of operators for any given task. These classes have their limits fixed by the production of the workers in them. As the productiveness of an operator increases or decreases, he moves from one of these classes to another, and consequently has his rate changed. If records have been accumulated, covering the performance of a number of workmen, it will soon be found that the workers will divide themselves off into fairly well-defined classes which can have different rates of pay assigned to them. It is unnecessary that the individual worker be working always on the same job or type of job to utilize this system. In case a record of the individual productive efficiency of each worker is kept on whatever task he may be working on, and then all the workers are divided into distinct wage groups, based on their general efficiency, rather than their efficiency on any one particular task, this system may be used on all jobs. Under a scheme of this sort, advances or decreases in the worker's rate may be made at intervals of one month or three months, or at any other period that is deemed best by the firm.

The second type of day rate based on production provides for the setting of day rates for jobs rather than for workers. Each job has a day rate assigned to it, which is far larger than the worker can earn by the ordinary day or piece rates that have been in force in the factory up to this time. At the same time that this high day rate is placed on the job, a standard is set for that job. If the worker makes the standard or better, he receives the high day rate. If he fails to make the standard, he drops back to the former piece rate of the job, or a new piece rate figured out in such a

way as to make the worker suffer a loss in his pay envelope due to his failure to make the standard. Usually, for the most effective operation of this type of wage-payment system, it is necessary that the worker's performance be figured over relatively long periods of time, and that he be not deprived of the high day rate merely for his failure to make the standard over a comparatively short time.

This system has the advantage of the ease in the computation of the payroll that is to be found in the day-rate scheme, and at the same time it enforces high production, which places it under the classification of an incentive wage. It is very useful in plants where the workers object to working on piece rate, and where, therefore, the penalty of failing to meet the standard will not only reduce their wage, but will serve to place them under a wage system that they do not like. If the system is fairly devised it is usually easy to secure the co-operation of the worker, and not difficult to secure the co-operation of unions.

Piece rates based on job study. Piece rates based on job study form the simplest incentive wage and generally a very effective one. Piece rates so set can readily be guaranteed by the management, provided provision for change in rate, if the operation be changed, is made. Piece rates thus set become an incentive wage because the worker realizes that there is no possible cause for him to peg his production at any point. In order that such rates may actually be an incentive wage it is essential that, after turning out the increased production made possible by the job studies, the worker's wage be appreciably higher than his previous or the prevailing community wage. The satisfactory administration of this system requires that if, for any reason not within his control, the worker is placed on a new job, one that he is unfamiliar with, or one that for any other reason, through no fault of his, he cannot make his high rate on, he should immediately be placed on a guaranteed day wage. This rate may best be the average of his piece-rate earnings over a definite, previously determined period. This plan is coming into very general use. It is simple and easily understood and does not involve any of the complexities of some of the more elaborate systems which will be described. If accompanied by the guaranteed day rate, it places the desired share of responsibility on the management.

The differential piece rate. The differential piece-rate system of wage-payment was devised by Frederick W. Taylor, as the method to utilize after conditions had been standardized, jobs studied, and tasks set. The system has two piece rates, a high rate, which is paid to workers who achieve the set task or better, and a low rate which is paid workers who fail to achieve the task. The high rate is set at a point considerably above the community standard, while the low rate is set at a point below the standard of the community. Thus the task time for a given job might

be two hours, with the high rate $1.25 for the task and the low rate 75 cents. If the worker did the job in two hours, he would receive $1.25, or at the rate of $5.00 per eight-hour day. If the worker took two and a quarter hours he would receive 75 cents, or at the rate of $2.66 per eight-hour day. Although this last figure is somewhat misleading, since it may be assumed that no worker allowed to work under this system would fall down on every job during the day, nevertheless, it will be readily seen that the system is severe on the worker who fails to make the task.

The intention of the differential piece-rate system was to exert a strong pull on a worker to do his task within task time. The assumption behind the system was that the management had gone to great trouble and expense to insure that all management factors were properly working, and the only reasons for failure to do the task within the allotted time would be within the control of the worker. If the worker were a first-class man, he would make his task. If he were not a first-class man, and could not be trained to be a first-class man, he would not be wanted, and, in fact, if he continuously failed to make his task he would be discharged. First-class men, making their task, would receive a compensation which would distribute between them and the management the savings of greater production.

The Taylor differential piece rate is not found, in its original form, in extensive use in industry to-day. The culling action at the point of achieving the task was found to be so extremely severe that the measurement of the task and the control of conditions set for the workmen had to be guarded with extraordinary care, in order to avoid complaint or feeling of injustice on the part of the workmen. The fact that the Taylor differential piece-rate does not guarantee a basic day wage is, therefore, the primary reason why it has fallen into disuse. Mr. Taylor recognized this point himself, for he said, " When, however, the work is of such variety that each day presents an entirely new task, the pressure of the differential rate is sometimes too severe. The chances of failure to quite reach the task are greater in this class of work than in routine work, and in many such cases it is better, owing to the increased difficulties, that the workman should feel sure at least of his regular day's rate." [1]

The differential piece rate has been modified by some plants, and is used in this modified form. This modification takes the form of making the lower rate equal to the prevailing rate in the community, rather than making it below the prevailing rate. The higher rate remains as before, far above the local average piece rate. The system then becomes essentially the same as the piece rate based on job study; except that there is still a sharp break at the point of the task, and the same as the task-and-bonus system, except that there is no guaranteed day rate as in the latter.

[1] Shop Management, Frederick W. Taylor, Harper & Bros., pp. 78–79.

The task-and-bonus system. The system known as the task-and-bonus system was devised by Mr. H. L. Gantt while associated with Mr. Taylor in his work at the Bethlehem Steel Company. In the later years of Mr. Taylor's life, he became a very hearty advocate of the use of the task-and-bonus system in practically all classes of work, and most of his immediate followers have lately used this system.

The idea back of task-and-bonus work is that an equitable bargain must be struck between the company and each employee. If the task is accomplished, the company will receive a definitely known minimum output at a lower total cost per piece than under the older wage-payment systems. In return for his effort to make the task which the company has set, the workman not only receives a reward which is large enough to make him wish to accomplish this amount of work, but also is guaranteed his hourly rate if he fails to reach the task. If he accomplishes the task, he is paid at his regular hourly rate for the time allowed for the task, plus a percentage of that time. This is equivalent to a high piece rate. Thus the workman has all the advantages of day work on a task he does not meet and all the advantages of high piece rates if he is proficient. The basing of the high rate on a day wage, although it takes the form of a piece rate, allows different rates to be given different workmen, where this is desirable because of the varying lengths of their service, or differing all-round abilities.

The task set on each operation is, of course, only determined after job study has disclosed the requirements of the work and the conditions necessary for its performance. As in all task-setting, but particularly with the use of this system of wage payment or that of the differential piece rate, it is essential that it be set in such a manner that it may be accomplished every time, and that small and unusual delays which cannot be specifically provided for will not cause a failure to earn the bonus. Every failure to earn the bonus should be investigated promptly after it has been checked up, and the conditions which caused it corrected. The task-and-bonus system is built up on the idea of the worker earning the bonus every time. This point is of some importance when considering the relative merits of this system and differential piece rates. Although task-and-bonus is theoretically presumed to be less severe on the workmen, yet in practice this may not be an important consideration, if the workers be trained to practically always make their task and if the bonus be large. Nevertheless, this theoretical advantage appeals to both workers and broad-minded managers and is of practical aid in the installation of the system.

Task-and-bonus work will fail unless the management has sufficient control of operations to insure that proper conditions for maximum output can be always maintained. This means not only that standards have been set, but that a proper system of purchasing, storeskeeping, and plan-

ning has been well established. Otherwise there will be a loss of bonus due to causes over which the workman has no control.

The bonus, under the task-and-bonus system, will be determined by the individual concern in accordance with its particular needs. It will usually range from 20 to 50 per cent of the task rate. In order to understand the operation of this system, let us assume a case where the rate is 50 cents per hour, and the bonus is 20 per cent of the standard rate. If a workman completed a five-hour job in six hours, he would receive a day rate for six hours, or $3 for the job, which is at the rate of $4 per eight-hour day (if he continues the remainder of the day at the same pace). If he did the work in five hours, he would receive the day rate for five hours, plus 20 per cent of five hours, or a total wage of six hours, or $3 for the job, which is at the rate of $4.80 for the day (if he continued the remainder of the day at the same pace). If he did the work in four hours, he would still receive the day rate for five hours, plus 20 per cent of five hours, making $3 for the job, or at the rate of $6 per day (if he continued the remainder of the day at the same pace). The system is seen to be a day wage for substandard workers and a task rate for men who are standard or better. Many plants use a much higher bonus than 20 per cent. Thus the Lewis Manufacturing Co. of Walpole, Mass., manufacturers of gauze and other like products, have largely utilized a 40 per cent bonus with the idea of strongly urging the worker upward toward his task.

Two major advantages of any task system of wage payment, and particularly task-and-bonus, are its beneficial effects on cost-predetermination, and hence quotations of selling price, and on scheduling work through the shop, and hence production control. It is in these respects that it differs most sharply from straight piece rates based on job study. In fact, were it not for these points, there would be no real difference between task-and-bonus and the straight piece rate with guaranteed day rate. Under the latter system the guaranteed day rate is usually somewhat lower than the amount which can be earned on piece rate if the time set by job study be reached. There are thus several intermediate stages between the number of pieces equivalent to the day rate and the number equivalent to the standard. Under task-and-bonus there is no such condition. The day rate holds until the task is achieved, when there is a sharp jump in the wage, caused by the payment of the bonus. This sharp jump at the task point has the effect of causing the worker to reach the task practically every time. There is no such urge under the straight piece-rate basis. The urge under the task-and-bonus makes it possible to predetermine the maximum time that the worker will probably take on the task. This in turn makes possible predetermination of overhead costs on the operation, provided these are figured on the basis of machine hour rates. This results in somewhat more accurate cost estimates than

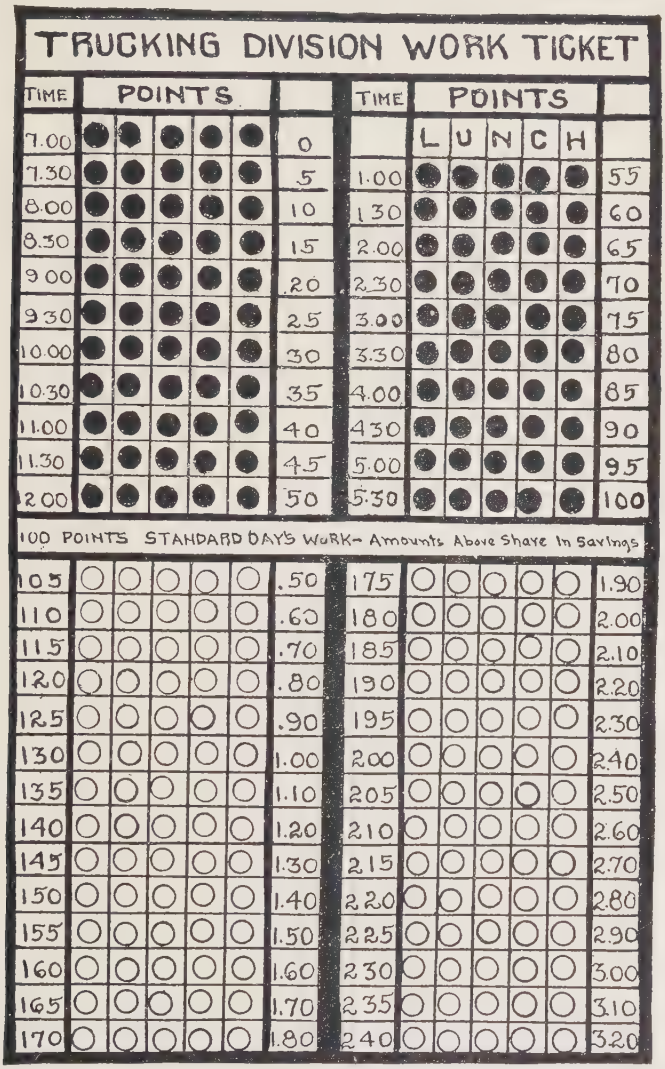
under the piece rate, where, although the labor cost may be uniform, the overhead cost may be variable. Furthermore, the pull toward task time makes it possible to schedule and despatch operations in the shop with the assurance that machines will be available at stated times. Although five or ten minutes on one operation makes no difference in this matter, accumulations of such times over many jobs may readily disorganize a whole shop schedule.

Any system of wage payment, to be useful, must be adapted to conditions at hand. The Curtis Publishing Company, of Philadelphia, has made a very successful adaptation of task-and-bonus to their factory operations and to allied work. The accompanying illustration (Fig. 59) shows one of their work tickets for their trucking division. The various runs which their trucks make to warehouses, freight stations, post offices, etc., have been carefully studied and timed. Each run has been evaluated at a certain number of points, on the basis of 100 points for a fair day's work. As a driver finishes a run, his work ticket is punched, thus giving him current information as to whether he is ahead of or behind his task. For each of the first 5 points above 100 he receives 10 cents additional, and for each succeeding point 2 cents. The urge to reach the task and go slightly beyond is evident. This is made possible of accomplishment because the basis of 100 points is in reality, based on the job studies, somewhat low, and a trucker should easily reach 102 or 103 points in making his standard task. Routes through uncrowded streets have been carefully mapped for him, and it is only under the most unusual conditions of bad weather that he is prevented from making 100 points or more through causes outside his control. All trucks are carefully governed as to speed to prevent violation of speed laws, and the savings come from attention to the job and rapid loading and unloading.

Foremen's bonuses under task-and-bonus. One of the more recent developments of task work with bonus, which has resulted in an increase in its effectiveness, is the payment of bonuses to foremen. The foreman of a department receives a bonus under this plan in case a certain specified percentage of the men under him are themselves receiving bonus. If a percentage of men below that designated is receiving bonus, the foreman receives only his regular salary, but in case the required percentage of workmen has achieved the bonus, the foreman himself receives a bonus. This bonus should be large enough to arouse the complete interest of the foreman.

The value of this addition to the task-and-bonus system is that without it the foreman frequently hesitated to teach the workman for fear that the latter might learn as much or more than he knew, and thereby possibly get his job. Under the new conditions, the man who knows is paid for teaching others as much as he knows, and the others are paid a bonus

for learning and doing what they are taught. This feature of the task-and-bonus system enables results, once attained through the installation of new management methods, to be permanent. The expert workman not only studies his job in order to secure his bonus, but is having his job



Courtesy Curtis Publishing Co.

FIG. 59.

continually studied by the foreman. Thus, all co-operate in removing obstacles toward increased production, instead of leaving it to the higher executives of the concern or the " inside " management man to be the only one changing conditions for the better.

The task-and-bonus system, or some adaptation of it, is probably, next to piece rates based on job study, the most frequently used of any of the incentive payment systems in industry to-day. It has been successful because it has required that management standardized conditions, study jobs, and otherwise do its part, has guaranteed the worker a day wage, and has provided a bonus which is, in general, neither too large nor too small for the full, hearty, and lasting co-operation of all.

The Emerson efficiency wage. The system of graded bonuses first developed by Mr. Harrington Emerson is somewhat similar to the task-and-bonus system. The day wage is guaranteed, regardless of performance. It differs in that bonuses are given to workers whose efficiency is less than 100 per cent, these being graded from the starting point up to 100 per cent, and in that efficiencies are not determined on a particular job, but over a pay period or longer. There is thus less of the drive on the worker to make task time on each particular job, because if he falls a little behind on one job he can make up on the next. There is, furthermore, a gradual pull on the worker, and a worker who is 98 per cent efficient makes more nearly the wage of the 100 per cent man than under the task-and-bonus system. Workers who are over 100 per cent efficient under the Emerson plan do not receive quite the wage of workers under the task-and-bonus system, for they receive their basic wage for the allowed time, but their bonus (which is usually 20 per cent) is figured on the time actually worked rather than the allowed time.

The efficiencies are expressed in terms of a percentage. Thus, if in one period a worker has actually worked 96 hours and has done work for which the standard time is 84 hours, his efficiency is $87\frac{1}{2}$ per cent. If he has done work for which the standard time is 91.2 hours, his efficiency is 95 per cent. If he has done work for which the standard time is 105.6 hours, his efficiency is 110 per cent. A sample bonus table under the Emerson system is as follows:

Percentage of Efficiency	Percentage of Bonus	Percentage of Efficiency	Percentage of Bonus
67.00 to 71.09	0.25	89.40 to 90.49	10
71.10 to 73.09	0.5	90.50 to 91.49	11
73.10 to 75.69	1	91.50 to 92.49	12
75.70 to 78.29	2	92.50 to 93.49	13
78.30 to 80.39	3	93.50 to 94.49	14
80.40 to 82.29	4	94.50 to 95.49	15
82.30 to 83.89	5	95.50 to 96.49	16
83.90 to 85.39	6	96.50 to 97.49	17
85.40 to 86.79	7	97.50 to 98.49	18
86.80 to 88.09	8	98.50 to 99.49	19
88.10 to 89.39	9	99.50 to 100.00	20

On the basis of these bonuses, the wages earned by the worker whose base rate was 50 cents per hour under the percentages of efficiency noted above would be:

Per Cent of Efficiency	Base Rate	Bonus	Total Wage, Two Weeks
87½	$48.00	$3.84	$51.84
95	48.00	7.20	55.20
110	52.80	9.60	62.40

Under the Emerson system, although there is less pressure on the worker to actually reach his task, there is also somewhat less pressure on the employer than there is under task-and-bonus to make his conditions entirely standard and to set his task exactly. Since the efficiency of the worker is not calculated on each particular job there is likely to be a tendency to feel that " conditions will average out fairly well in the long run." The one distinct advantage of this situation is that a worker cannot work at maximum pressure on one job, and thus make an extraordinarily high wage and then take it easy on the next job, with the assurance of his day wage. The pay-roll expense that is saved because efficiencies must be determined only once in a pay period is counterbalanced by the more elaborate and fractional bonus rates. It is also more difficult to predetermine costs under this system than under either straight piece rates or task-and-bonus.

The workman may be paid during a given period on the basis of his efficiency in the next preceding period, or on the basis of his efficiency in the period itself. In case he is paid on the basis of his efficiency in the next preceding period, he naturally gets all of his wages for the current period at the same time. If he is paid on the basis of his efficiency during the current period he will not receive his bonus wage with his regular pay envelope, as it will be necessary to figure the bonus wage prior to giving him his pay. It makes no real difference which way the wage is computed.

The accompanying chart (Fig. 60) should prove valuable as a ready reference for comparison of the various wage-payment systems, and for information concerning their effect on various phases of operation.

	Older Systems		Incentive Systems based on Past Performances		Incentive Systems based on Job Study and Task Idea				
	Day-Rate	Piece-Rates without Job Study	Halsey	Rowan	Day-Rates based on Production	Piece-Rate	Differential Piece-Rate	Task and Bonus	Emerson
Guaranteed Day Rate	Yes	No	Yes	Yes	Yes	Possibly	No	Yes	Yes
Incentive for Worker to reach Maximum Productivity	No	Not Usually	Possibly	Possibly	Possibly	Yes	Yes	Yes	Yes
Maximum Spur to Best Possible Management	No	No	No	No	No	Possibly	Yes	Yes	No
Spur to Worker to reach Carefully Set Task	No	No	No	No	Possibly	Possibly	Yes	Yes	Somewhat
Payroll Computation	Easy	Fairly Easy	Difficult	Very Difficult	Easy	Fairly Easy	Fairly Easy	Fairly Easy	Very Difficult
Labor Cost Predetermination	Impossible	Easy	Difficult	Very Difficult	Fairly Easy	Easy	Fairly Easy	Easy	Difficult
Overhead Cost Predetermination	Impossible	Difficult	Difficult	Difficult	Difficult	Difficult	Fairly Easy	Fairly Easy	Difficult
Quality Maintenance	Entirely dependent on character of product, methods of supervision and inspection, and other means taken to promote quality.								

FIG. 60.

CHAPTER XXVI

SPECIAL TYPES OF BONUS PAYMENT

Group bonuses. When the nature of the task requires that workers be formed into groups, the members of which are dependent on one another as regards output, some form of group bonus usually proves most practicable. This plan also has the additional advantage of enlisting the co-operation of all workers in bringing up substandard workers. An example of such a bonus plan is found at the plant of the Saginaw Malleable Iron Co., Saginaw, Mich. A group bonus has been applied there to a group of workers employed to pick up castings in the foundry, break off the gates, sprue, etc., delivering the casting to the cleaning room and the sprue to the charging car. The unit of performance was made 1000 pounds of good castings produced, and the standard time figured in man-hours per unit. If the tasks are accomplished in the time set, the workers receive a bonus on their hourly wages, as under any bonus system. The bonus is figured on cumulative efficiency during the pay period, and to the base pay of each man is added the percentage of bonus which the group earned.[1]

Quality bonuses. In considering incentive wage systems the question is constantly asked, "Do not such systems tend to increase quantity of production at the expense of quality?" At times, in actual usage, there seems to be so much stress on securing maximum quantity of production, that quality cannot help but suffer. This has caused manufacturers producing a quality product to hesitate to use them, particularly to turn to them from the day rate. There are two general remedies which can be applied to this situation that will help keep up quality equally with quantity while the worker is trying to earn his premium or bonus wage. The first of these remedies is to insure stringency of inspection, the second is to utilize some sort of a quality wage bonus.

If strict inspection standards are maintained and the workers know that quality must also be a result of their efforts or material will be returned to them for reworking or they will be otherwise penalized, quality will usually be maintained. In the usual type of work a proper inspection system will ordinarily prove to be sufficient inducement to secure quality. Bonuses for quality are more frequently found only where quality, not

[1] See "Management," A. B. Gould Co., January, 1923, pp. 58–62.

quantity, is of paramount importance though they are also used at times where quantity is also desired. The Joseph & Feiss Company uses a quality bonus of 15 per cent of the production wage, on some operations. This can be earned without the production bonus, but the latter cannot be earned unless the quality be standard.

Action by the inspection force of a plant has the negative effect of penalizing the worker. Quality bonus systems operate in the opposite way. They are positive inducements towards better quality and pay the worker for quality instead of merely penalizing for lack of quality. Quality bonuses may be used with any wage system that has been discussed. In some cases they may form the only type of incentive wage that is used. It will thus be observed that quality bonuses divide themselves into two classes, (1) those which are utilized where quantity bonuses are impossible, or at least impractical, and (2) that type of quality bonus which is used in conjunction with some form of quantity bonus to make a composite wage system in which the pull on the worker will be both towards quantity and quality.

Methods of utilizing quality bonuses, where they represent the only type of incentive wage in effect, will be best described by illustrations. One type of work which is best put on an incentive basis by the use of quality bonuses is inspection work. It would be manifestly hard to pay inspectors in accordance with the amount of work they might turn out. This would be conceivably possible, as, for instance, a payment in accordance with the number of defects discovered. Such a system of payment would, however, be largely dependent on the skill of the worker rather than of the inspector and would also probably result in considerable argument between the workers and the inspectors as to whether or not work were up to standard. A better system is to over-inspect the inspector's work. That is, to have chief inspectors who will test sample lots of material that have already passed through the hands of the regular inspection force. Bonuses can then be paid on the basis of the perfection of inspection that the inspectors have achieved. Such a plan is entirely feasible on any inspection job, but is unquestionably more feasible in cases where a large amount of similar material passes through the hands of the inspectors constantly.

Another illustration which will indicate the manner in which quality bonuses operate will be a rather elaborate one describing the quality bonus system in use in the plant of the Nashua Gummed and Coated Paper Co., Nashua, N. H. This plan is particularly noteworthy because of the number of peculiar features which are involved in the bonus system. It shows to what extent the payment of bonuses can profitably be carried, and indicates that the bonus idea can be applied to almost any kind of a job. This bonus plan has been developed in the color-mixing room of

this plant, where quality is more essential than quantity, where all the work is essentially group work, and where the workers each perform more than one job in a working day. Such a situation involves about as many complicating situations as could be found in the ordinary plant, and many managers would have hesitated to try anything but day work under such conditions.

In this mixing room there are four men working, one of whom is practically in charge, though he is a leader rather than a foreman. The work of these men is interdependent, and they must perform during the course of the day four general types of jobs, each of which must come up to a quality standard that has been set. These jobs, are, (1) preparation of color mixtures, (2) keeping cans of mixed colors in condition for immediate use, (3) filling mixers in the coating room where the colored coating is applied to the paper, and (4) cleaning the " monitors " or mixers.

The group of four men are paid one basic day wage, which is divided among them in percentage based on their experience, rather than the actual work which each of them does, as this latter cannot be determined. If all of the four jobs above mentioned are satisfactorily performed the gang receives a stipulated bonus for that day which is also divided among them in the same proportions as the day wage. If inspection of the work that they perform on a certain day indicates that one of the four jobs has not been satisfactorily performed, one quarter of the day's bonus is deducted. If two of the four jobs have not been satisfactorily performed, one-half of the possible bonus is deducted; if three of the jobs prove unsatisfactory, three-quarters of the bonus is deducted; and if none of the jobs are up to standard, the workers receive no bonus, but only the day wage for that day.

It will be well to indicate what the basis of inspection on such jobs can be. On job (1) the principal basis of inspection is the percentage of moisture in the mix. A variation of 2 per cent of moisture is allowed without loss of bonus, but beyond that percentage of error, the bonus is lost. Thus if the correct percentage of moisture on a given job were 50, if the moisture were found upon inspection to be 49 or 51 per cent, the bonus would be made. If the moisture were found to be 48 or 52 per cent the bonus would be lost. On job (2) the test is largely one of appearance, for the trained man can quickly determine whether or not the color has been kept properly stirred, and hence in condition for immediate use. This task is a necessary one, inasmuch as the colors sometimes remain mixed for some days prior to use, and will deteriorate unless properly stirred. On job (3) the test is whether or not the mixers in the coating room are kept filled up to a certain stipulated number of gallons at all times and whether orders have been withdrawn without wastage. The purpose of this bonus is to prevent stoppages on the coating machines because of the lack of available color. On job (4) the condition of the machines is inspected as

being "good" or "bad." This is, of course, based on the judgment of the inspector, but it is a job on which the bonus can be easily earned. The inspection work described is not caused by utilizing the quality bonus. It would have to be carried on in any case and experience has indicated that it is made easier through the utilization of the bonus.

This illustration serves very well to show how quality bonuses may be paid without reference to quantity of production and indicates the types of jobs which lend themselves to the payment of quality bonuses. It is equally easy to combine the payment of quality bonuses with bonuses for quantity. The combining of such bonuses will prove an immediate check on rapid increase of production without regard to quality. Thus, in the weaving of cloth, a bonus may be paid on the production which is secured from the loom, while another bonus may be paid if the defects which are discovered in a certain number of yards of cloth are kept below a certain number. The relative amount of bonus to be paid for quantity and quality will vary with the importance of quality in the particular instance, as for example, the value per yard of the finished fabric.

One type of work on which great success has been secured through a combination of quantity and quality bonuses is typing work in large offices. Very successful task and bonus schemes have been based on the number of lines of output per hour, or the number of square inches of typing per hour which are produced. Of course, the number of mistakes which are made by the typist will have a very distinct effect on the value of the work. Therefore, quality bonuses have been devised which pay the typists extra wages in case the number of mistakes in a specified number of lines or square inches of work is held below a stipulated amount.

A combination inspection system and quality bonus has been devised which is known as the "Debit and Credit Bonus." This is used on processes which involve a number of very short operations, as in some of the needle trades, where the cost of inspection after each operation would be prohibitive. Under this system each operator forms a check on all preceding operators for the quality of their work done. If she discovers a defect in quality she reports it to the foreman and receives a stipulated bonus for so doing, which is charged against the worker making the error. It is an automatic inspection scheme which is very harsh in its application, but which frequently has proved very effective in bringing up quality on short operations.

Bonuses based on amount of equipment in operation. A type of quality bonus may be developed to reward those whose tasks are directly related to keeping equipment in operation. The work of such persons is so varied that it is difficult to set predetermined tasks, but it is possible to base bonuses for the whole group in percentages of equipment in operation. Thus the Aberfoyle Manufacturing Company, of

Chester, Pa., gives bonuses to its loom fixers and smash fixers based on the number of looms in operation as follows:

5 per cent—1100 looms in operation.
10 per cent—1200 looms in operation.
15 per cent—1275 looms in operation.

This particular company extends this bonus to include persons on previous operations, on the basis that it is the prompt accomplishment of their work which helps make possible the operation of the number of looms in question. The dyeing room and beaming room thus share in bonuses based on the number of looms operating. It is evident that the basis of such bonuses must change from time to time as operating conditions change.

Attendance bonuses. The next general type of special bonuses to be considered may be termed "attendance" bonuses. These are special bonuses paid for perfect attendance or a percentage of attendance up to a specified standard. Attendance bonuses may be for attendance only or may include extra payment for promptness, or the payment for promptness may be the only type of attendance bonus granted. Bonuses of this type are frequently paid in money, but are often paid in the form of vacation or added days on vacation. If paid in money the amount is not usually very large. If paid in vacations, a basis that is frequently used is one day's vacation (or extra vacation if the factory is already on a vacation basis) for each month of perfect attendance.

Attendance bonuses are of great value in increasing output since they aid continuity of attendance on the part of the working force, thus insuring that any production programme that is mapped out will not be hindered by lack of personnel to carry it through. The promptness bonus is particularly advantageous in this respect, inasmuch as it usually results in almost uniformly prompt attendance throughout the factory. This enables the production department to know, soon after the factory doors open, what vacancies in the factory force must be filled in a given department on that day, in order that production may be kept flowing smoothly and up to schedule.

There is one element in the idea of attendance bonuses that is not altogether pleasing to a large number of plant executives. That is, that the payment of such bonuses results in the duplicate payment for something that the factory is already paying for. It is claimed that when a person is engaged he is expected to be at the factory on all working days and to be there promptly. Therefore, an attendance bonus should be unnecessary and is a payment which is undesirable. This argument has much strength in theory, but the facts of experience have indicated that a small attendance bonus is an expenditure well made, as it most distinctly

does serve to bring in the workers on time every working day and also decreases the days "out." In times of slack production attendance bonuses are likely to be quickly eliminated.

Length of service bonuses. One criticism that is to be found in paying all men on a given job the same rate of pay, or pay varying only as their production varies, is that it does not take account of the length of time the worker has been with the concern, his loyalty and general knowledge of plant conditions. Inasmuch as it is sometimes considered poor policy to pay more than one base rate or bonus for a given job, some plants have solved their problem by the payment of a service bonus. This bonus, usually a percentage of earnings, is paid regardless of the type of work which is performed or money earned in a given period, and it increases as the length of service increases. Some plants have begun the payment of service bonuses as soon as six months after the employee has entered the employ of the concern, while many have deferred the payment for as long periods as five years. The basis of this payment will depend on the type of worker that the company desires to reach, and also on the length of service that is necessary to really make the employee of extra value from a producing standpoint.

Overtime or odd-shift bonuses. Payment for night and Sunday work, as well as for overtime work, is frequently made on a bonus basis. The familiar "time and a half for overtime" is not the only method of paying for this type of work, although it is more common for overtime work than it is for night or Sunday work. For instance, out of 51 plants studied in the Middle West, 47 paid time and a half for overtime, while practically all of these paid less, and usually some sort of a bonus, for the night shift. Some of the plans for payment of bonus for night shift work are as follows: (1) payment of a certain stipulated number of hours pay per week in addition to the pay for the number of hours actually worked on the night shift, e.g., payment for three or five extra hours, (2) payment of a bonus of a certain number of cents per hour worked on the night shift, as 2 cents or 5 cents per hour, (3) payment of a certain percentage of the day rate in addition to the day rate for night work, as 10 per cent or 15 per cent. The increase of the base rate for night work need in no way effect the operation of an incentive wage system, as the premium or bonus can be figured out on the night base rate as easily as it can be figured out on the day base rate.

Foremen's bonuses for accident reduction. Bonuses can be worked out for almost any feature of industrial activity. This is particularly true in the case of executives' or supervisors' bonuses. One of the types of such bonuses that is most frequently found is the foreman's bonus for accident reduction. Many of the pioneer safety men were opposed to the bonus idea. They stressed primarily the humane motive in urging the

need of accident reduction, and were, for the most part, of the opinion that to offer a formal bonus would lessen the force of the humane appeal. On the other hand, those who advocated the use of such a bonus contended that the accident problem was essentially a production problem, and that any successful device that could be used to reduce accidents was justifiable. Thus we find accident reduction bonuses paid to a large number of foremen and other supervisors in the more dangerous trades in the United States, for instance, in the iron and steel industry.

The development of such an accident-reduction bonus is not a simple affair. The amount of the bonus must be gauged not only on the basis of the number of accidents, but the severity of the accidents, that is, the number of days that the worker loses from his job. The object is not only to be humane, but to keep a force on a given job constant. To go into the methods of building up such a bonus system would be unnecessary here, and, therefore, attention will be given only to the results that may be achieved by it. Information is available concerning these results in the iron and steel industry over a period of years, and the table below speaks for itself as to the desirability of such bonuses in dangerous trades.

ACCIDENT FREQUENCY RATES PER 1000 WORKERS [1]

	1912	1913	1914	1915	1916	1917
Bonus plants	179	102	36	45	36	36
Non-bonus plants	186	173	107	98	130	90

[1] Monthly Labor Review, U. S. Dept. of Labor, Bureau of Labor Statistics, Sept. 1919, p. 272.

(Blast furnaces, steel works, and rolling mills are included in both the figures for the bonus plants and for the non-bonus plants.)

PART VII

PERSONNEL RELATIONS

CHAPTER XXVII

THE PERSONNEL POLICY

The extent of plant morale may best be measured by the degree of co-operation that is extended to the management by the workers during the ordinary routine of operations. This co-operation is not always achieved entirely through the payment of high wages, through extensive service work, or even through participation in the management by the employees. All of these factors will be found to influence it, yet in many plants where numerous steps have been taken toward bettering these phases of management, success has not been achieved in building a morale equal to other plants wherein these phases have received but little thought. Under older types of management morale was frequently unconsciously developed to a higher degree. Under newer types success in creating morale has frequently not been large, despite conscious efforts in that direction, after many other "betterments" in management method. Such instances are caused by lack of confidence in the management on the part of the employees. They incline to be the exceptions to the rule, because newer management refuses to accept as either inherent or necessary, an attitude of disinterestedness on the part of the workers. Under older management methods, where morale had not happened to develop, such a condition was taken as a matter of course. To-day every effort is being made in far-seeing organizations to create and arouse the interest of the worker in his work. If these attempts are successful, many of management's most vexing problems are solved.

The strength of labor and the constant urgings of students of the social sciences have aided materially in bettering the basic personnel policy of industrial plants. However, it is impossible to shut our eyes and ears to conditions existing in some plants where those in control seem to feel that to secure more dollars of profit is synonymous with entire disregard

for the worker. In answer to queries concerning personnel policies, two factory executives recently remarked, " There are plenty more workers like the ones we have. If they don't like their work, they can quit," and, " I guess we've hired every laborer in this town, and some of them two or three times, but if they don't like to work here, we can bring in some who do." Such attitudes happily are passing rapidly. Plants which are attempting to create and maintain morale among their workers try not only to maintain a stable working force, but to arouse in the minds of individual workers the conviction that their jobs are important, and that they are important members of the industrial community. All phases of modern management assist in this. Thus, the setting of exact tasks for a worker raises rather than lowers his morale, inasmuch as it gives him a buoy to steer by; while the development of an incentive wage system, being a means of recognizing merit in a worker, indicates to him the importance of performing his tasks as expeditiously as possible. It is the development of such points of view in the workers' minds, quite as much as the material rewards involved, that made for the success of these systems.

Development of the creative spirit of the worker. The development of the workers' creative spirit is, over long periods of time, one of the most successful means of raising plant morale. We all have the desire to make something, to see the results of our labor. If those who direct the workers' effort will take this into account, his co-operation is likely to be assured. Although the shoe-worker of to-day cannot make the whole shoe, he can be allowed to see and perceive what he is doing. The desire of mankind to express initiative or creative spirit has frequently been misinterpreted to mean that workers desire a share in the management of industry. Careful analysis has revealed that, regardless of participation plans, the co-operation of workers is best assured when they recognize their part in the whole process of production, and understand thoroughly the operation of their own department and the organization as a whole. Effective instruction of the workman, rather than allowing him to " pick up " his job, is one of the most vital forces in this direction. The finely subdivided tasks of modern industry, and the highly repetitive work frequently involved, challenge management to find methods to allow the workers' creative spirit to develop. Modern management methods may be used to repress the employee or to allow his fuller development. It is the task of management to insure that the latter result is achieved. If this phase of the worker's energy be not guided into constructive channels, it is very likely to seek for itself destructive ones. Thus the worker who day after day is kept at the bench on a repetitive task, and who sees paper forms regulating what work he shall do and when he shall do it, is likely to build up a fairly solid aversion to the forms. But if the operation

of the controls which they represent is explained to him, if he is shown how they enable the management to insure proper processing and filling of orders on time, and if he has the opportunity to see and understand the charts which correlate the information on his and others' time tickets, not only will he begin to see the spirit of the game, but he will make suggestions to improve the way it is played. The development of such spirit and co-operation in the worker implies a high caliber of foremanship, and it also implies that some portion of the management has it constantly in mind as its primary objective.

The field of the personnel department. Plant morale is so intangible and its development so difficult that it was not until the growth of the personnel department in industry that most concerns paid any conscious attention to it. Many personnel departments, mechanistically conceived, have gone about the various phases of their work without seeing their relationships to this most vital factor. The personnel department which has for its object only the hiring of the worker, his training, and the supervision of the workers' activities that do not deal directly with production, has not begun to visualize its task. This department must take the productive process as it finds it, and develop, with the aid and co-operation of the production executives, this intangible thing, plant morale. It must seek ways and means of looking at the plant through the eyes of the worker, in order that it may take steps to eliminate, either directly or with the co-operation of the general and production management, those factors which are the cause of the failure of the workers to co-operate.

The personnel department is that section of an organization that can be continuously looking at operations from the viewpoint of the worker. And, regardless of its own particular method of organization, this is its primary reason for being. To organize a personnel department does not imply that line executives may cease to think of the workers' point of view. It merely means that there is in the organization a department which will now continually bring the workers' point of view to the line executives. Neither does the creation of a personnel department relieve the general management of the necessity of considering major policies with the workers' point of view in mind. No personnel policy will succeed which does not have the original and continuous backing of the general management. But details of operation, rather than broad considerations of policy, may frequently absorb the time of the general management. It is the function of the personnel manager to keep the general management in constant touch with the pulse of the workers, and to guide them toward decisions which will make for whole-hearted co-operation of the workers. The personnel manager should be in such constant touch with the worker that he may readily interpret for the general management pulse-readings which are abnormal, but which might to them seem normal.

In other words, it is the one basic function of the personnel department to develop and adhere to a long-run policy which will create and maintain good-will on the part of the employees toward the management and the employer. All minor portions of personnel policy are dependent on this fundamental, and it is the task of the personnel manager to see that the operations of the busily engaged line executives do not interfere with the growth of the good-will of the employees toward the concern. This is true regardless of the title or announced scope of authority of whosoever may be in charge of personnel work, and regardless of how much detailed personnel administrative routine must be carried on by that person. It is a task of the personnel department to prove to the worker that he is not a cog in the machinery of production, but rather a vital section of the machine, regardless of how small his share in the productive process may seem to be.

There are some fundamental points of contact in the relationship of the firm and the employee that the personnel manager must continually have in mind if he is to prove successful in the development of his personnel programme on the basis just outlined. Among these are security of employment, hours, wages, and working conditions. If these factors, which come directly in his province to discuss with the general management, are soundly developed, he will find it relatively simple to carry on the more routine expressions of the personnel policy as developed in the next few chapters. The importance of security of employment is particularly likely to be lost upon the line executives, as they analyze production and sales schedules, or as they consider cost reports. There is hardly anything of greater importance in developing the interest, confidence, and good-will of the employee than security of employment. Restriction of output and other hindrances to production programmes on the part of the workers may generally be found to rest on a fear that they will suffer unemployment if they adopt any other programme. The personnel manager should therefore have as the keystone in his own programme, keeping this fact constantly before the other executives of the firm. He should see that all operation programmes which are developed be so warped as to make possible the carrying on of his ideal. Operation programmes which do not provide for this factor he should criticize severely and continually, and it should be his task to thereby keep the attention of the major executives focused on the effect of their decisions on the long-run labor policy. In all matters affecting hours, wages, or working conditions, which involve fundamental effects on the plant as a good place to work, he should not only be consulted, but his advice should weigh heavily in the final decision.

The most effective way in which the personnel manager and his department may assure the worker of their interest, and that of the firm as a whole, in his problems, in an intangible one—their general attitude. To

secure the co-operation of the workers on the basis of such an attitude is a gradual achievement and one that is based on effective handling of particular situations. There are many ways for a personnel department to work towards this aim, but, regardless of particular ways which may be described, the most effective methods will occur to the personnel staff at particular times and under particular conditions. One primary step is to provide for the hearing of any complaints with reference to wages, treatment, or conditions, to investigate these complaints, and to endeavor to adjust them and prevent their recurrence. Although it is a fundamental that the personnel department shall thoroughly understand and be sympathetic with the employee, in this relationship they must not forget their obligations to the production forces nor the requirements of production. Unless they continually keep these in mind, they will shortly become an outlaw group in the minds of those executives who are continuously faced with production difficulties. Nevertheless, the interests of the employees must necessarily be the primary interest of the personnel department.

The Plant Publication. One of the most successful ways of developing and maintaining the right basic personnel policy is through the plant publication. Such an organ will thoroughly acquaint the employees with each other and with the management, and it may be readily utilized as a means of expressing the fundamental concepts of the employer and the management, and frequently, what the workers are thinking as well. The plant paper is particularly valuable in this connection in organizations whose units are widely scattered, although its value is by no means limited to such cases. Of course, there have been many plant papers published which have made no attempt to cover labor policy and have been put out merely with the hope of, in some general way, increasing the good-will of the employees. While these are usually valuable, it is to be regretted that they do not further make themselves useful by considering the labor policy. Not much space is needed for this, and the large majority of the space in the magazine may still be used for educational, inspirational, and local-comment material. However, in order to form a background for the basic personnel policy of the plant, it is necessary that the plant paper be well edited, and of real interest to the employees.

The proper position of the firm in the life of the employee. One of the basic points in the development of a personnel policy is a thoroughgoing philosophy concerning the place in the life of the employee that the plant should hold. Paternalistic concepts of the employer-employee relationship cannot but help destroy morale, and yet the personnel department must stand ready to co-operate with any outside interests, municipal or private, which may be taking steps toward general betterment of conditions within the community. Peculiarly, the more the personnel depart-

ment thinks through its problems of plant-morale development, the more it is likely to extend into paths and methods of activity which lead directly toward paternalism. The type of work within the plant and within the community which has the greatest possibilities for the development of industrial good-will has also the greatest possibilities of paternalism.

There are times and conditions under which it is essential for a plant, in its endeavors to bring about a radical change for the better in the mode of living of its workers, to adopt, for a short time, a paternalistic attitude. An outstanding illustration of this was the case of the Ford Motor Company when they raised wages, for the first time, to a minimum of $5 per day. If they had made the large wage increase which this involved, without demanding certain standards of living and saving on the part of the employees in return, it is quite probable that this wage would have resulted in lasting detriment to the company, the workers, the community, and the idea of a high wage. Furthermore, some plants, located in communities which are unable to provide amusement for their citizens because of their size or remoteness, frequently find it necessary to provide living and recreational facilities for their employees in a manner which may smack of paternalism. This may not prove pernicious, providing it is properly handled. What must be avoided are plans which indicate that the company feels it controls the entire life of the worker, merely because it is his employer.

CHAPTER XXVIII

THE EMPLOYMENT DEPARTMENT

The development of the employment department idea. Through the need for better understanding between employer and employed, through the increasing complexity of modern industry, and through the growth of the functional and staff ideas, the employment department in industry has developed. It undertakes one of the most fundamental of personnel functions, the securing and maintaining of an adequate personnel for operations. This department had its inception in conditions which had grown up through the continued presence of large masses of floating labor in American industry. For years, with the supply and adjustment of labor left to the superintendent, foremen, and other department heads, thoroughly taken up with the performance of their line functions, there had developed a condition of hiring and firing and a cycle of coming and going, with little thought of the consequences.

Although these conditions did not develop overnight, a realization of the desirability for their elimination did. It was not until the attention of managements, the country over, was forcibly drawn to the dollars-and-cents losses involved in high labor turnover that steps on a large scale were taken towards placing the hiring and maintaining of the working force on a sounder basis. One of the pioneers in this was Mr. Magnus Alexander, then of the General Electric Company plant, at Lynn, Massachusetts. In a series of forceful addresses throughout the country, during 1914 and 1915, he hammered home to the business community the expenses incident to continued replacement of working forces. His figures were based on a study which he had made. He pointed out that firms changed personnel from one to three times a year, and explained that this meant a loss of from $8 to $200 for each man hired. This loss he carefully measured under various headings, such as direct costs of hiring, instruction in the jobs, increased wear and tear on equipment, increase of spoilage and decrease of output.[1] His studies and those of others aroused unparalleled interest throughout industry, and plants which had developed employment departments were constantly importuned to describe their methods of operation. Although it was quickly recognized

[1] See Annals of American Academy of Political and Social Science, May, 1915.

by all that much of the turnover was due to unavoidable separation, yet most seemed to be traceable to causes that seemed preventable.

Plants which had centralized in a functionalized employment department the hiring and maintaining of the working force seemed to have lower turnover figures than those which had left these phases of operation in the hands of the foremen and other department heads. There quickly developed a scramble to organize employment departments and to give these departments control over many phases of personnel work which were not directly concerned with the employment function. Frequently, because of the haste in organization, the right man and the right methods were not found, with the usual disastrous results of haste. However, the employment department idea came not only to stay, but to grow, and every subsequent analysis of labor turnover figures for groups of plants indicated that those plants with the most highly developed employment and personnel work had the lowest turnover records. Thus, in an analysis made by the United States Bureau of Labor Statistics in 1918, it was found that even under the unusual wartime conditions, in Detroit, which was practically 100 per cent on wartime production, those plants which had carefully developed labor policies, and which had centralized their employment functions, had turnovers ranging from one-tenth to one-half of plants which were devoting but little attention to personnel or employment work.[1]

Centralization of employment work for the production forces can be justified on the following grounds: although the foreman may have much knowledge of the detailed requirements of jobs, his experience and the time that he is able to devote is not such as to usually make him expert in the selection of workers; the foremen cannot be expected to develop outside contacts as sources of labor in a way that a centralized department can; individual foremen are not in a position to perceive the needs of the plant as a whole, and thus the centralized department is more likely to achieve that uniformity in selection which makes for a generally high character of personnel and *esprit de corps*, to place an applicant in the department for which he is best suited, to better arrange in merited cases for a transfer of jobs, and to better prevent undesirable former employees from being rehired. If centralization of employment of the production forces be once achieved, it is likely that the same policy will be shortly extended to all other departments of the business.

Qualifications of employment department personnel. To insure the high standards of operation which are usually expected from the creation of the employment department, the employment manager must be a man of broad vision and winning personality. He must not only be able to win the confidence, sympathy, and appreciation of the employees,

[1] See Monthly Labor Review, January, 1919, pp. 11–19.

but of the heads of departments. Though this latter has at times been found somewhat difficult in the beginning of centralized employment within an organization, successful operation over a period of time will usually largely eliminate conflicts and bring with it co-operation of department heads. In order to build up this condition, the employment manager is frequently forced to keep his eye on long-run policies, rather than on individual cases in which he may differ with a department head. As a means of promoting harmony, it is usually essential that it be understood that final selection of applicants is in the hands of the department head. Under this policy, with the development of a well-run employment office, the cases in which selections made by the employment department will be rejected in the operating department will be very rare indeed. There is usually no necessity of sending more than one candidate to the department head, because, after a period of time, the employment manager soon learns the types of workers whom the department head simply does not like to have around. At times, after an employment department has become fully established and has gained the confidence of all departments, it is possible to place full responsibility for the selection of employees in its hands; but there should always be an interview between the applicant and the department head before final employment, so that the former may see what kind of a person he is going to work for and not meet his " boss " just as he is taking his coat off to get to work.

To make for soundness of selection, it is essential that the employment manager, or his assistant, whoever interviews applicants, shall have a firsthand knowledge of the requirements of jobs. Thus, an interviewer of applicants for workers in the shop should have shop experience. No matter how complete the employment department's record of jobs, there is no substitute for this. In addition to these qualifications, it is, of course, essential that the interviewer be specially qualified in power of analysis, in knowledge of human nature, and in constructive imagination.

In selecting employees, the employment department must fill requisitions which are submitted to it by the operating departments. These requisitions may be developed in conference at the time that some production or expansion programme is decided upon, or may take the form of routine requisitions, which may be made out on specified forms, submitted by the departmental heads from time to time as necessity dictates. The cause of the vacancy should be indicated on the requisition, in order that the employment manager may have a continual check on the way in which he is meeting the requirements of the departmental heads. If this is not provided, it is barely possible that the employment department may be continuously selecting ill-fitted employees for given jobs. Of course, if the contact between the employment manager and the department heads is as close as it should be, this condition will rarely arise, and when it does

arise, it will be usually due to the inability of the employment department to secure workers who are best fitted for their tasks, which condition they will already know. The requisition should reach the employment department as far in advance of the time the worker is actually needed as is practical.

Job specifications. The employment department is greatly assisted in its operations if it has developed a set of job specifications for all jobs for which it is called upon to supply workers. These specifications are of particular value in large organizations, where it is impractical for the employment manager or the interviewer to keep in mind the conditions of work of all jobs. In smaller organizations, it is possible that they will have a knowledge of the jobs which is more complete and accurate than anything which is likely to be developed on paper. Much information for job specifications can be secured from the methods department, or whoever has control of the taking of jobs studies. The employment manager should be entirely familiar with the job-study data which have been secured. In working up job specifications for his purposes, however, he frequently needs some information of another kind, and must also translate for his purposes much of the information on the job-study observation sheets. Job specification data should not be too elaborate. There is likely to develop a tendency to detail a mass of information which it is impractical to utilize. Particularly when business conditions are good, it is impractical to try to fit workers too closely to the job at hand. This does not mean that every attempt must not be made by the employment department to find workers who closely approximate the ideal for a given task. It does mean, however, that if the ideal, as represented by the job specification, represents a class of worker that is utterly unattainable, in compromising with the conditions at hand, it is likely that the actual worker provided will be further from the ideal than if the job specification were less detailed.

Job specifications aid, not only in the selection of the employee, but in his training and possible promotion. If they are intelligently utilized by the employment department they aid in preventing the over-selling of the job to the prospective employee, with the resultant high leaving rate within a few weeks after employment. They should include a consideration of minimum qualifications of the employee, rather than maximum, a full statement of the conditions under which the work is done, in order that the interviewer's memory may be refreshed when he is seeking a worker for a job, should indicate the pay, and the lines of promotion which seem to be open from the job. (See Fig. 61.)

Sources of supply. The development of sources of supply for workers and keeping in contact with these is one of the chief duties of the employment department. An available supply of workers when wanted is

likely to be most frequently found by those organizations which have created for themselves the reputation of being good places in which to work. The establishing of this reputation may be far beyond the powers of the employment department, involving, as it does, the whole personnel policy of the plant as well as its methods of operation, but it is of inestimable value in the development of a satisfactory, as well as a satisfied working force. The wage base can do more to provide or prevent applicants of the right character than most of the professional activities of the employment department together. Plants in large cities have the prob-

1	2	3	4	5	6	7	8	9	10

JOB NAME THE AMERICAN PULLEY CO. JOB SPECIFICATION

DEPARTMENT 1. GENERAL SYMBOL

2. MINIMUM QUALIFICATIONS OF OPERATOR

☐ MALE ☐ FEMALE ENGLISH ☐ READ ☐ WRITE ☐ SPEAK SCHOOLING ☐ COMMON ☐ HIGH 1234 NATIONALITY PREFERRED FROM AGE TO SIZE ☐ TALL ☐ SHORT ☐ HEAVY ☐ MEDIUM

TRADE EXPERIENCE NEEDED PHYSICAL

3. NATURE AND CONDITIONS OF WORK

LOCATION	POSTURE	SPEED	ACCURACY	SIZE OF MATERIAL	AUTOMATICITY	HEALTH HAZARDS	DANGEROUS FEATURES	ACCIDENT HAZARD

MACHINES USED PERSONAL TOOLS REQUIRED

TOOLS USED TIME REQUIRED TO LEARN OPERATION

DEPARTMENT HEAD EMP. DEPARTMENT DATE

Fig. 61.—Front of Job Specification Card.

lem of building up a good reputation in their particular portion of the community, inasmuch as it is found unsatisfactory to have large portions of the working force come from long distances. In no case is it usually possible to stop hiring persons who live at a distance from the plant, particularly when business is booming, but a good reputation within the nearby community will do much to add neighbors to the working force and thus eliminate the lateness, absence, and high turnover which usually follow long rides to and from work. In small communities, where the prospective labor supply is limited, the possibility of securing the best available workers rests squarely on the general reputation that the plant builds up.

A large proportion of new workers must necessarily be selected from those who apply at the office, although this is generally the least satis-

factory source of supply, particularly in good times. Applications by mail are frequently received, and they form a satisfactory source, particularly in the case of firms with good employment reputations, who are likely to attract workers already employed. Of course, follow-up interviews are necessary before selection, regardless of the amount of correspondence. Advertising for workers in newspapers merely increases the number of these two types of applicants. Workers already employed are likely to recommend names for consideration. Their recommendations may easily prove one of the best sources of supply, since they know the plant conditions and are not likely to recommend the names of others, unless they feel that these will also be satisfied. However, there is a great difference between this, and the selection of two workers, particularly girls, who apply together for the first time. It is likely in the latter case that if one of these workers becomes dissatisfied for any reason, the other will leave along with her.

Of the contacts which can be developed between the employment department and outside organizations, those with employment agencies are the least desirable. Except in the case of a few state agencies, these are likely to be only interested in finding a job for their applicants, regardless of fitness, particularly if they are private agencies working on the fee basis. A better class of contacts, particularly if unskilled employees are wanted, is with the leaders of foreign elements within a community, either business men or clergymen. They are likely to know the reputation of workers within their group and will be glad to recommend the better ones as opportunity offers. Trade organizations are valuable aids, especially when there is some form of collective bargaining with labor in the plant. In some industries where collective bargaining has been established, particularly in the clothing industry, joint offices have been provided as an aid to the plant employment managers. Schools, colleges, and specialty concerns who train workers in business practice, such as filing device distributors, all form valuable contacts. Frequently close relationships can be built up with technical high schools that will yield a very satisfactory source of supply consisting of their graduates. Candidates for future executive positions are more and more found in graduates of colleges, and many such institutions have provided departments which aid the employment manager to get in touch with their students as well as with graduates who have been in the industrial world for some years. Each personnel department will ordinarily develop contacts which seem particularly desirable for their peculiar conditions, and upon the extent to which they have developed these will frequently depend the promptness with which they can fill requisitions made upon them.

Interviewing the applicant. It is in the interview with an applicant that the employment department has one of the best opportunities to

justify its existence. It is not only in the selection of successful candidates that this is true, but in the method of selection, in the method of rejection, which should be such as not to create any ill-will towards the firm, and in drawing out of the candidate those points which are pertinent to a consideration of whether or not he is likely to be a permanent member of the working force. There can be no cut-and-dried method of interviewing. Each person must be treated in a different manner, and in a way which seems to best fit the case and to best draw him out. It is in drawing the applicant out that the success of the interviewer rests.

Application blanks have frequently been looked upon as the most important feature of the process of selection, and many of these have been designed from the standpoint of asking of the applicant every possible question that could be devised. This is wrong. Application blanks should be made as simple as possible, the questions asked should all have a bearing on the applicant's fitness for a particular job, or right to membership in the organization. (See Fig. 62.) Personal questions, which may aid the interviewer in determining the desirability of the applicant, should, however, be asked in the interview rather than on the blank. The tendency should be towards the procedure of the Curtis Publishing Company, where there is no "application blank," but in its stead is an "experience record." Furthermore, the application blank should be handed to the applicant in a way which will secure his co-operation in filling it out, rather than to have the effect of making him look at it as a piece of useless mechanism which must be filled in before the real business of the day can start. This is but one step towards the idea that if the interviewer is to really learn pertinent facts about the applicant, he must be made to feel more or less at home. He is not likely to feel at ease in walking into a new plant, unless he be the undesirable type of applicant, namely the "floater." The application blank may readily be used by the interviewer as a means of beginning the conversation with the applicant in the attempt to find out what kind of person he really is. This is one of its most valuable features, but the blank should not be looked upon as the basis of all hiring. It does form a valuable record of prospects in cases of applications of eligible workers for whom there are no immediate openings.

In all employment work, the major task of the management is to make the employee or prospective employee act in a wholly natural manner, and "open up" in conversation. Since this is true, it is desirable that all features of the employment office shall be constructed with this idea primarily in mind. It is therefore desirable that where a majority of persons being employed are women, the interviewer should be a woman, and where the majority of applicants are men, the interviewer should be a man, inasmuch as workers seem to express themselves most freely to members of their own sex. This holds true also for the higher positions in the

DATE.....

NAME: ADDRESS

ANY EXPERIENCE IN TEXTILE:

IF WEAVER WERE YOU ON PLUSH SINGLE SHUTTLE / DOUBLE SHUTTLE BROAD SILKS, UPHOLSTERY, CARPETS, DRESS GOODS, BLANKETS:

WOULD YOU CARE TO LEARN WEAVING, MENDING, WINDING, FINISHING, BEAMING, WARPING OR TWISTING:

IF NO POSITION NOW SHALL WE PUT YOU ON WAITING LIST:

WHERE SHALL WE WRITE YOU:

NEAREST TELEPHONE IS: WHOSE PHONE IS IT:

WHERE LAST EMPLOYED: ADDRESS:

WHAT POSITION DID YOU HAVE THERE: WHAT WAGES:

WHY DID YOU LEAVE:

DO YOU KNOW ANYONE IN OUR EMPLOY:

WHAT EDUCATION OR APPRENTICESHIP:

MARRIED: SINGLE: WIDOW: MAN: WOMAN: AGE..... HEIGHT..... WEIGHT.....

CITIZEN
NATIONALITY.....APPEARANCE, VERY NEAT, NEAT, FAIR, DIRTY, BAD:

IMPRESSION AS TO INTELLIGENCE, VERY GOOD, GOOD, FAIR, UNFAVORABLE:

GENERAL IMPRESSION:

INTERVIEWED BY

FIG. 62.—APPLICATION BLANK

personnel organization. Courtesy on the part of members of the employment staff is a fundamental necessity, if the plant is to be regarded in the community as a "good place to work." However, the attitude of the employment staff in this respect will nearly always reflect directly the basic policies of the company, without any conscious effort in that direction.

One of the mooted questions of personnel work is the matter of employment tests. Much has been written and many experiments have been made with these tests, both trade tests and mental tests, including general intelligence tests and rating scales. Their place in industry is still a matter of controversy, but it may definitely be said that they cannot be relied upon too extensively. Trade tests, which presume to directly test the abilities of the applicant for the job by having him do some work along the lines in which he is supposed to be skilled, unquestionably eliminate the "bluffer." But frequently it is necessary that a worker be given a chance to produce over a long period, because of the peculiar type of work or arrangement of machinery in the plant, or because of the scarcity of skilled workers at the time. If performance tests are set up there is a tendency to demand that the worker perform the operation in a particular manner, the methods rather than the results being what counts. Workers who would have difficulty in passing the ordinary trade test sometimes become among the most valuable in the plant under the guidance of a careful and painstaking foreman. Performance tests are valuable for simple types of work, such as typing.

Trade tests, which consist of showing the applicant a picture of a machine and then asking him a series of questions concerning it, or asking him for other similar trade information, are somewhat more valuable provided the test is used as a part of the general interview, and not given as would be a Civil Service examination. Although the poorest worker may readily pass the best examination, in case his mind happens to run in such channels, nevertheless if properly devised such tests may gauge the actual ability of the applicant with considerable exactness. Oral tests which are included in the interview should be checked with workers' performance after being hired, in order to ascertain whether they actually are a guide to proficiency. If those who made the best records in the tests also make the best production records, the test may be presumed to be of value.

Mental tests, such as general intelligence tests, are of less proved value in the selection of workers. Many claims have been set forth for them, but they largely remain to be proved. Intelligence tests may give some idea of mental quickness or general knowledge, but they have not been developed to give a convincing test of fitness for specific jobs. Mental tests which are so designed as to check some particular ability may be regarded as somewhat more successful. Thus a test which will indicate

quickness of perception may be utilized as a partial guide in hiring persons to do assembly work on small parts. Rating scales, which may be of some value in the promotion of executives, providing the rating be intelligently done, have but little or no place in the selection of applicants for any position. Their usefulness for promotion purposes has also been found from a practical standpoint to be questionable. All methods of character analysis by means of physiognomy have been proved useless, and most advocates of these methods found to be fakers in the highest degree. Any tests which are based on this idea are in reality only making the applicant for employment subject to the fundamental or acquired prejudices of the interviewer.

It is the task of the interviewer to sell the plant to the applicant, and to sell it to him fully, but it is likewise his task not to oversell either the plant or the job. The foundation of many other personnel activities is to be found in the impressions gained by the worker in his first few days in the plant. If the interviewer is successful in his relations with the workers whom he is interviewing, he can develop an attitude toward the plant which will go far to make the worker feel at home during the first trying days. No matter how badly a worker is needed, it is distinctly bad policy to oversell the job. This may be done by exaggerating its good points, or by consciously or unconsciously not mentioning all its bad points. This last may be due merely to the familiarity of the interviewer with the job. But the bad points will quickly be discovered by the worker, and if he be not prepared for them, they will appear so much the worse to him, and there will be all the more likelihood of his not permanently staying with the job. And meanwhile there will have been a good deal of cash expended on him, and other qualified applicants may possibly have been cast adrift.

Physical examinations. In plants having physical examinations of applicants, with a doctor always in attendance, this examination may readily be given before introducing the worker to the foreman. In plants where the doctor only pays periodic visits, the examination may come after the worker has been provisionally at work for a day or two. This mainly depends on the purpose of the examination. It is largely used to-day, not as a means of complete rejection, except in cases of communicable diseases, but as an aid to intelligent placement and follow-up. Unless there are physical examinations, it is very likely that workers will be assigned to jobs which are beyond their strength, or to which they are peculiarly unadapted from the physical standpoint, when they might as well have been assigned to jobs which they could satisfactorily perform. Many workers and some workers' organizations have objected to physical examinations because they have felt them to be predicated on the idea of rejecting the employee if he was not 100 per cent physically perfect. Of course, there is usually no such idea, but nevertheless there

is a certain fundamental reaction which springs up in large numbers of men against taking a physical examination before they are given a job. This is a fact which must be recognized and guarded against.

The Curtis Publishing Company has recognized this and has seemingly found the solution. Instead of applicants for employment being told that they must pass a physical examination before being sent to the job, they are told that it is desired that they should meet the plant doctor. He is there for the purpose of aiding them in case they shall become ill, and therefore they should meet him and know who he is. No prospective employee can object to this sort of an introduction. In fact, he is usually glad to meet the doctor. He and the doctor begin to talk about commonplace matters, the last job the man had, etc., until the doctor can easily swing the conversation into a discussion of his health. Then it is discovered that the man is subject to frequent headaches. The doctor suggests that it may be due to defective eyesight, or other similar cause, and asks the man, for instance, if he has ever had his eyes examined. This leads in turn to an examination, and the doctor is enabled to secure as much of a physical examination as he deems necessary without the worker objecting. In fact, there is developed a bond of friendship between the doctor and the worker which causes the latter to be very ready to come for medical advice in the future.

Introducing the worker to the job. The function of employment does not end with acceptance of the worker by the employment department, and with his acceptance of the job. One of the best ways of having a new worker become dissatisfied with plant conditions is to have him not understand them. If the new worker is started to work without any adequate explanation of the aims and policies of the concern, and if his job is detailed and repetitive, day in and day out, is it surprising that he cannot readily be gotten to listen to tales of the "real aims of the plant"? It is desirable that he be given a bird's-eye view of the plant, its history, policies and aims, and be shown his connection to all of this. One of the commonest ways of attempting this is through a booklet which is handed to the employee at the time he begins work, and which may have any title except "Regulations." Some concerns place the name of the employee on the cover of the book. As previously stated, a personal introduction of the worker to the man under whom he is going to work is a necessity. Either the foreman or the employment department representative should be careful to introduce the new employee to those around him, and to show him the facilities for his personal comfort, such as locker and wash rooms, as well as those phases of plant routine which intimately concern him, such as entrances, clocks, methods of securing pay, and various service features. The R. K. Le Blond Company, of Cincinnati, has its director of employees' service send a letter to each new employee during the

first week of his employment, inviting him to a dinner at noon in the plant restaurant the following week, at which time a special table is reserved and he not only has an opportunity to meet his fellow-workers, but all important safety, employment, and recreational features of the plant are described.

Not only should the worker be properly introduced to his job, but he should be carefully followed up, especially during the period immediately after he is employed. That is the period of most difficult adjustment, and the time during which the heaviest turnover figures are run up. In some plants, representatives of the employment department, sometimes even the interviewers themselves, go to the various departments and talk with those who have been recently hired, in an attempt, not only to secure the reactions of the worker to his job, but to check up on the judgment of the employment department, so that transfers may be made if necessary and advisable, at the time they will do the most real good.

Transfers and promotions. Inasmuch as the employment department is charged with providing a satisfactory working personnel for the organization, it follows that control of transfers from department to department or of promotions must rest largely with it. The matter of transfers is often a ticklish problem, particularly if the reason for transfer may have been the fact that the employee did not get along with the head of his department. The latter may readily rise to a point of personal privilege and demand that the worker not only leave his department, but the organization as a whole. This will frequently be difficult to deny, and almost as frequently unwise to deny. But there are times, even in disciplinary cases, where it is desirable to transfer workers from one department to another. If the general impression is created that workers are in the employ of the concern at large rather than in any particular department, this practice is made easier. It may, however, easily be run into the ground, and cannot be carried on at the expense of discipline. Most transfers will be caused by errors in placement, rather than personal difficulties within the department.

A promotion system, which frequently involves transfers, is a most valuable adjunct to any personnel policy, where it can be worked out. Lines of promotion should be clearly defined wherever possible, and every effort made to create real lines of promotion. Frequently simple promotion schemes are effective, such as transferring a worker from dirty or greasy work to clean work, or from a night shift to a day shift. One of the reasons why a well-developed system of promotions and transfers is necessary, is that if some such scheme is not worked out, there will be small chance of preventing the department head from keeping his best workers in the jobs that they hold. He is principally out for production at lowest cost. That is why he is there. When he finally gets a round

peg fitted into a round hole, and a square peg fitted into the famous square hole, he wants to keep the pegs right where they are and not start his carpentry work all over again. Many employment managers have had the same feeling. But most good men will not " stay put " in the same job all their life. That is one reason why the rate of labor turnover is not necessarily indicative of the health of the industrial community at large, however indicative it may seem to be of the health of a single plant.

A promotion scheme, including a lines-of-promotion chart, cannot always be drawn out and posted, particularly in small organizations. Nevertheless, the employment department always can be working toward such a scheme; and in large organizations, where there are the most blind-alley jobs, the development of the idea is easiest. The aim is to insure that the worker has the maximum of responsibility and earnings possible, and the firm has the benefit of the greatest ability. In working out such a programme, quantity and quality of work, length of service, attendance record, number of dependents, age, and physical and mental fitness must all be taken into account. Where it is impossible to work out lines of promotion from job to job, it is usually possible to work out a scheme of wage increases with length of service, which, while not providing the same spur for all workers as changes in position, readily serves for some.

Discharge, Quits, Layoffs, Records. Policies differ concerning the extent of control of the employment department over discharge of employees. In most plants which have developed employment departments, the employee must at least pass out of the plant through the employment office, in order that a record may be obtained of the reason for the severing of the connection. Some plants allow the department head only the power of discharge from his department. However, if the matter has gone so far that an executive of the organization has actually discharged a worker, it is usually impractical to arrange either that he take the worker back, or that he submit to his transfer to another department. It is best to provide for a procedure whereby the department head comes to the employment office and talks the matter over before discharging the workman. If such a procedure be enforced, there is always a possibility that the department head may change his mind, or he may approve a worker's transfer to another portion of the organization, thereby saving the concern a portion of the investment in the individual, in cases where such action might be justified.

When the employee voluntarily quits, provision should be made that he be not allowed to draw his final pay until he has checked out through the employment office. This will enable an effort to be made to retain him, in case this should be desired, and at any rate an attempt may be made to secure information concerning his reasons for leaving. Such information is of more value than the mere preparation of statistics. It

enables the employment department and, through it, the general management, to understand the features of the plant itself and the industry in general which must be remedied if the costs of labor turnover are to be reduced.

Many times men are laid off from the working force of a department because of a reduction of work there, who can readily be used in other departments of the concern. In such cases, an orderly procedure, rather than a mere dismissal of the employee, will frequently result in the retention of many employees who can be used in other positions.

A statistical analysis of the number of workers employed in each department, the number hired over a period, and the number of exits, carefully classified, is a measuring stick of the effectiveness of the labor policy of a plant, and of the effectiveness of operation of the employment department. The number of exits should be carefully subdivided as to voluntary withdrawals, those laid off, and those discharged. It is in the subdivisions of these main causes of exits that the most valuable data will be secured for the development of the personnel policy. Whether the voluntary withdrawal is because of dislike for the work, "better job," which frequently should be interpreted higher pay, conditions at home, or other reasons should be fully investigated before the employee is allowed to leave. At times the real reason cannot be ascertained; but at other times, if as much care is given to the interview when quitting as is given to the interview at selection, some real information will be secured for policy-determination. The first cause given by the worker cannot be accepted always as the real one. In addition to a compilation of causes of turnover, the employment department can prepare other interesting and valuable bits of statistical compilation, such as, an analysis of the working force according to earnings, according to length of service, or nationality. These analyses can also be combined with turnover statistics by departments as an aid in policy-formulation and better selection.

CHAPTER XXIX

SERVICE WORK

Next to "efficiency man," the most unpopular phrase in the industrial vocabulary is "welfare work." The idea that this constituted doing something for the working man which would better his "condition," coupled with the plant advertising features which frequently were part and parcel of it, has eliminated welfare work from successful industrial management. In its place has been substituted "service work." Not that there is anything in a name, but there is much in the different attitudes which these two phrases express. Service work includes all those activities which are not directly concerned with production, but which make the plant personnel a healthier, sounder-thinking, more forward-looking group. To avoid the pitfalls which caused the idea of welfare work to fall into disrepute, the plant must studiously avoid any semblance of the attitude of saying, "See what we are doing for you." The only excuse for a management including service work as a portion of their programme is that it will make the employees a group of citizens who will be better able to carry on the productive processes, or that it constitutes a development which has been approved by the express will of the employees.

Careful analysis of the motives of the plant management in engaging in service work will enable it to better understand whether some particular feature is or is not a desirable adjunct to work already carried on. Thus the fundamental concept should be carefully analyzed by the personnel department and the plant management as a whole, to see whether the work is carried on wholly because it pays, since it acts as an incentive to the working force, or partially on humanitarian grounds. Depending partially, but not entirely, on this analysis will follow the method of organization of the work, that is, whether it shall be carried on by some branch of the personnel organization, perhaps called the service department, or whether it shall be organized as an employees' activity, possibly supervised by the management. Wherever service work can be organized on the latter basis, greater results will ordinarily follow from an equal amount of effort. However, some company contact with the situation is necessary not only to give advice, where needed, but also to prevent the activities from degenerating into the football of opposite political camps within the employee group.

Locker rooms and rest rooms. There are certain features, generally classified under service work, the desirability of which cannot be questioned, either from the standpoint of the employer or of the employee. They are in reality a portion of any sound policy of operation and are placed under the personnel division merely for convenience of administration. Such activities are the operation of adequate locker rooms and wash rooms. Locker rooms should provide individual lockers and wash rooms should be constantly supervised and kept clean. Rest rooms for women

Courtesy S. B. & B. W. Fleisher Co.

FIG. 63.—Women's Rest Room, S. B. & B. W. Fleisher Co., Philadelphia, Pa.

(Fig. 63) come under this heading, and are uniformly desirable, if maintained on not too elaborate a scale. The objection is sometimes heard that they have a tendency to keep women workers away from their job unnecessarily. In large plants rest rooms must be supervised, but this would be true, no matter how meager the wash-room facilities, even though they came in only under the letter of the state law. The fact that rest rooms can only be utilized for a short period of the day, during the noon hour, is no argument against their establishment. They are provided to be used when needed, and as a means of relaxation during the period.

Simple furnishings, and perhaps a phonograph, bring only a small drain on the resources of the company, which is paid back amply by the added production of the woman worker who has felt the need of using the rest room for a few minutes before the afternoon working period or perhaps during the working hours. The demonstrated fact that workers seldom use these rooms after working hours, which has discouraged some plant managers, has no significance. They have ordinarily been established as an aid to the day's routine, not as club rooms.

Health service by the medical department. The functions of the plant doctor have come to include more than a physical examination of applicants. Many organizations in which there are no physical examinations for employment have a plant doctor, either on a full-time or part-time basis. The proportion of time that he is at the plant usually depends somewhat on its size. He maintains a dispensary with a nurse in attendance, not only for accident, but for health (Fig. 64). If the plant be fairly large and the doctor be on a part-time basis, the dispensary is usually in charge of the nurse, who, when occasion demands, will also go out to the homes of workers who are ill and who desire her aid. This home visiting may take the form of a systematic follow-up of all workers who do not report for duty on a given day. When thus organized, it has the added purpose of decreasing absenteeism. Such home visiting must be carefully handled if the attitude of paternalism is to be avoided.

The greatest function of the medical department, if organized to give health service, is to keep the worker well and on the job. If the confidence of the workers can be secured so that they will report to the dispensary when they first feel ill, it will usually eliminate a large share of absenteeism, and may possibly check the spread of an epidemic within the plant. This was clearly demonstrated at the plant of the Joseph & Feiss Company, of Cleveland, during the influenza epidemic of 1918 19, when the percentage of illness and absenteeism was kept at a point but little above normal, through the competent administration of the factory dispensary. If a dispensary is maintained, even though it may be in charge only of one of the personnel force, specially trained, all workers suffering accidents, however minor, should be immediately reported for treatment. Persuasion, as well as regulations, should be used in this direction. Signs, similar to Fig. 65, have come to be commonplace in promoting this practice.

If a medical department to give health service be installed, it is best that it be under the control of a highly competent physician, even though he give only part of his time to the work. A medical department can do much to reduce compensation claims and loss of production time, but only if it is skillfully directed. Industrial physicians and nurses must necessarily fully understand the human side of their daily contacts. They

must at least be given a cheerful place in which to work, and one that is central enough to make it convenient to all the workers. It has been found impractical for most plants employing less than 500 workers to employ a physician on full time. Plants employing from 500 to 2000 workers may or may not employ a full-time physician, while plants with over 2000 workers almost uniformly do. These facts, together with the cost of medical department operation, have been worked out in a very complete study by the National Industrial Conference Board.[1] This

Courtesy S. B. & B. W. Fleisher Co

FIG. 64.—Dispensary, S. B. & B. W. Fleisher Co.

study indicates that the annual cost per worker of well-organized medical departments will range about a $4.50 average, with the cost for the smaller plants being higher, or in the neighborhood of $6. These figures cannot be viewed properly without considering the reduction in compensation claims and lost time and the increase in general contentment, due to the good health that such departments bring. Put aside from the monetary aspects, the general betterment of the health of the community which is likely to result from providing facilities for workers to consult competent

[1] Research Report No. 37, National Industrial Conference Board, pp. 10–11.

physicians, should weigh heavily in favor of the introduction of plant health work.

The well-organized medical department will be able to collect a mass of highly useful data for the personnel and production executives con-

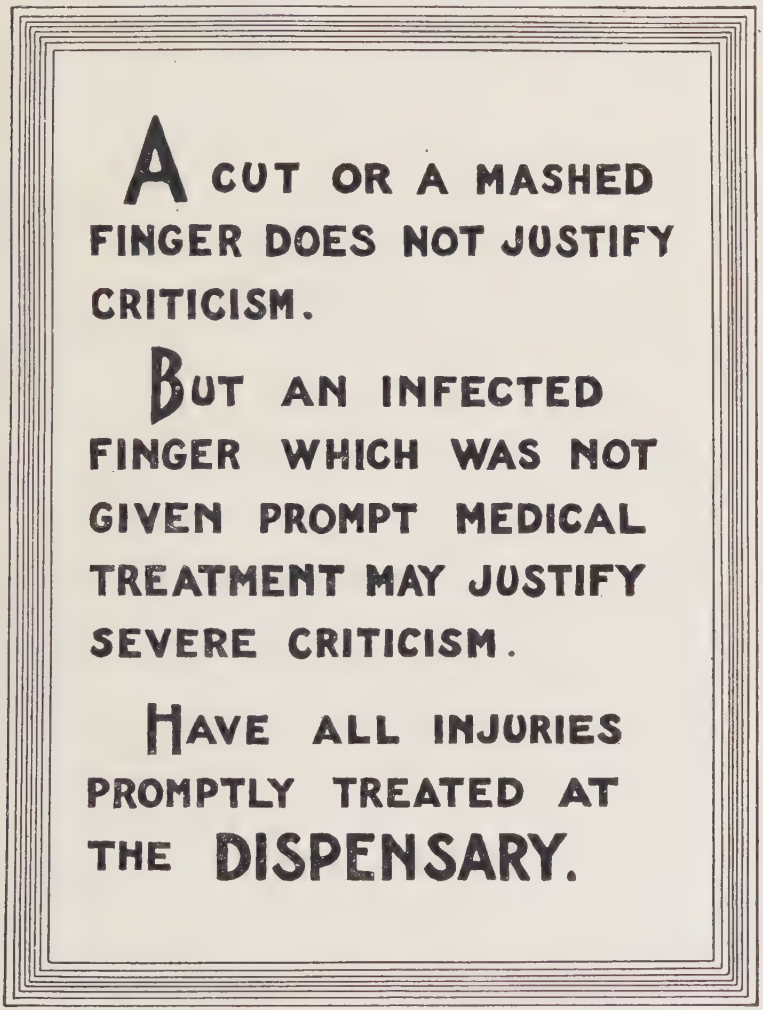

A CUT OR A MASHED FINGER DOES NOT JUSTIFY CRITICISM.
BUT AN INFECTED FINGER WHICH WAS NOT GIVEN PROMPT MEDICAL TREATMENT MAY JUSTIFY SEVERE CRITICISM.
HAVE ALL INJURIES PROMPTLY TREATED AT THE DISPENSARY.

FIG. 65.

cerning unhealthful conditions and unsafe operations within the factory. The checking of causes of absence can be done only by a factory nurse. The only possible excuse for entering a workman's home when he does not report for work is on the basis of being helpful if he is sick. If it be found upon calling that the worker's absence is due to any other cause

there is but one procedure, namely, to withdraw promptly. Any other action is paternalistic to an impossible degree. Nevertheless, a clever factory nurse can secure much useful information in making her rounds, and her value in reducing absences is not confined to aiding ill workers to return to work more promptly. Her visits have a strong moral value, too, inasmuch as they indicate more strongly than any amount of regulations by the management, the importance of being on the job. No plant can long afford to carry workers who are consistently absent without cause, and the factory nurse is the proper person to find out the cause. The visiting nurse will serve as the basis for administration of sick funds maintained by any mutual benefit association in the plant. She should also be closely in touch with any charitable organizations in the community which might be interested in aiding workers whose illness has left them temporarily in bad financial situations. Some companies feel strongly that it is very desirable that the handling of such cases be called to the attention of such duly organized agencies, and left with them.

Dental work has been added to the field of operations of some medical departments. Employees are usually charged for this service, though the prices are ordinarily based on cost of materials, with possibly some addition which partially pays the dentist's time. The large number of cases of ill health which are traceable to the teeth are usually felt to be the justification of such work, if it exists. In some cases, while the work is done on company time, the actual cost of the work to the company is charged to the employee.

The R. K. Le Blond Company is an example of a plant which maintains an eye room for treatment of accidents to the eyes, and the prescribing of glasses. They have materially cut down the number of eye accidents by this means, cutting the number in five years to one-tenth the original, and have reduced the amount of time lost from production correspondingly.

Health service can be made very profitable to both the employee and the plant, but every effort should be made to secure the good-will of the employees toward the idea, in order that they will not hesitate to visit the dispensary. Much can be done toward the creation of the desire to visit the dispensary in the first contact which the physician makes at the time of physical examination. Care must be exercised in the operation of a factory health service that it does not unjustifiably infringe on the province of the local medical community, and particularly on the precincts of the family doctor of the employee.

Educational work. In turning from medical work to educational work a field of service work is entered which can be very readily overdone. This type of educational work does not deal with the training of the worker for his job or for direct advancement, but deals with general

education along varied lines, such as Americanization and thrift. Such work can frequently best be carried out by the formation of clubs among the employees, which will be able to carry on the educational work with but little guidance from the service department. If a plant library is to be established, which is sometimes particularly desirable in small towns, it can best be put under the supervision of some employees' club or association, although it should not be necessary that any employee be a member of that organization in order to secure the benefits of the library. Americanization work can readily be carried on by interesting some employees in it, and allowing them to act as instructors for the group. Educational work along the lines of thrift and sound financial advice is frequently possible, but can probably best be carried on through the plant paper. "Before you invest—investigate" is a slogan which has proved helpful in the development of a sound investment campaign. In case there are savings funds or other similar plant organizations, thrift education can best be handled by these.

Restaurants and cafeterias. The maintenance of plant restaurants and cafeterias has become almost universal. Even when the neighborhood is blessed with fair places to eat, it has come to be regarded as desirable to institute a plant cafeteria. These make possible not only the development of an *esprit de corps* through the meeting of fellow-workers, but insure that workers will toil through the afternoon hours properly nourished. It is these features that make the restaurant a dividend-paying investment. Since profit is forgotten, costs in factory restaurants are usually a fraction of costs in ordinary restaurants. This is particularly true because costs are usually based on cost of food and service, overhead being eliminated. With poorer portions of the working force, and with women workers who are also housewives, the factory restaurant makes for an opportunity to get at least one good meal a day. Women who would not take the trouble to cook themselves a real meal at home, even if they had the funds to provide it, will frequently make the noon meal at the factory their main meal of the day. Thus the factory restaurant, like the medical service, tends to promote the health of the worker.

Where it seems desirable, the restaurant may be given to a restaurant company or an individual on contract, providing careful supervision is maintained over its operation. Wherever possible, it is desirable that it be operated by the plant itself. The establishment of a plant restaurant makes possible the enforcement of regulations against eating in the workrooms, and it is most desirable that these should be enforced. Practically every company maintaining plant restaurants allows the workers to bring a portion of their meal from home if they so desire. The cafeteria style of restaurant finds most favor because of the lower cost and the speed of its operation. (See Fig. 66.)

The restaurant may readily be made the center of service activities of the firm. If entertainment features are desired, these can be provided in the restaurant, either during the noon hour or at other times. It can be made the center of employees or departmental functions, and gives an assembly room upon which there is little desire or likelihood of encroaching.

Recreational and Athletic Activities. In the attention paid to recreational and athletic activities lie some of the dangerous spots of service

Courtesy Notaseme Hosiery Co.

FIG. 66.—Restaurant, Notaseme Hosiery Co., Philadelphia, Pa.

work. Recreational features may take the form of dancing, music, or speeches during the noon hour (see Fig. 67), plays, band concerts, or dances given by workers at intervals throughout the year, or the development of clubs and club-houses. These features, particularly the latter, are bound to fail unless the basic wage of the plant is right. The workers will quickly see that they are costing the firm an outlay of considerable money and will be likely to demand that it be put into their pay envelopes, unless they are already fairly well satisfied with the contents of these. If professional talent be available, it may be called upon infre-

quently for short concerts during the noon hour with satisfactory results. However, speeches are not usually received with pleasure, and many workers show the disposition to want to spend the noon hour as may strike their fancy. Plays and dances are valuable if they are fostered by the employees, through organizations of their own, who only call upon the service department for guidance. They are particularly workable in small towns. The plant band in the small-town organization likewise becomes a unifying influence for good, whereas in the big-town organization it is

Courtesy S. B. & B. W. Fleisher Co.

FIG 67.—Recreation Room, S. B. & B. W. Fleisher Co.

likely to fail, except in large plants, where it is usually regarded as would be a professional organization. Clubs, particularly country clubs, laid out on a large scale, cannot possibly be successful unless the management has the complete good-will of its employees. There is too much opportunity for the criticism of large expenditures. If the *esprit de corps* has not been worked up to a high pitch before the opening of the club, it will be difficult to get whole-hearted co-operation of all elements within the working force for its support. Clubs after formation cannot be operated except as employees' organizations, and since they involve large investments on the part of the company, it is necessary that steps be taken

when they are organized to prevent internal politics in these organizations from wrecking the project. If a plant be properly situated, and if all fundamental conditions be right, there is no feature of service work which will do more to cement the mutual understanding of all elements within the plant than will a club. (See Fig. 68.) However, it is essential that all employees, whatever their plant status, be given an equal status within the walls of the club, if this is to be true.

Courtesy Aberfoyle Manufacturing Co.

FIG. 68.—Country Club of Aberfoyle Manufacturing Co., Chester, Pa.

Athletics, while valuable, have been carried to an extreme in many organizations. Inter-departmental competitions tend to raise the spirit of the departments, and girls' or men's basketball teams, and men's baseball teams are particularly successful. Athletics develop health and encourage that most valuable asset to any industrial concern, team play. They develop plant consciousness and leaders. If plant teams are formed, the tendency towards professionalism and hiring workers merely for their athletic ability must be guarded against. Although for the moment a good team may seem to increase the interest of all the workers in the team and hence in the plant, nevertheless, there will soon be murmuring about fav-

oritism. Even teams which are composed of bona fide employees tend to take the primary interest of the members during the playing season, and winning from other plants becomes so important that the routine work of the week is frequently relegated to the background. In small towns, where the company team is in reality the town team, these objections are frequently wholly outweighed by the good-will which the team will build up in the community. But too much time, too much attention, and too much money can readily be bestowed on athletic work which emphasizes competitive rather than health features.

Employees' Group Funds. Particularly in large organizations, funds which are built up through associations of employees are valuable from the standpoint of the employee and the plant. Such funds are those of building and loan associations, benefit associations, and savings funds. Company group insurance plans and retirement plans are also very successful. The company cannot successfully operate savings funds itself, but it can urge the establishment of Christmas savings clubs, vacation funds, or building associations, and can lend the time and experience of one or more of its executives or lawyers to act as an advisor to such groups. The boards of directors of such associations, to be successful, must be almost entirely composed of workers, with probably one representative of the management who will sit for the purposes named. Associations of employees formed for savings purposes of one kind and another form one of the most excellent foundations for the beginnings of co-operative management, such as will be later described. Savings funds usually work out best if they have some particular purpose in view, such as is found in Christmas savings clubs.

Group insurance plans are largely utilized by companies as means of putting a premium on length of service. They are sometimes used together with increased wages for length of service, but frequently form the only length of service bonus. The company usually pays all premiums on this insurance. As an example of such a plan, the J. B. Stetson Company gives to each employee of three months' standing a policy of $200. The amount is increased to $400 at the end of six months and to $500 at the end of a year. One hundred dollars is added annually thereafter until the policy amounts to $1000. All foremen and assistants receive double this amount, and in addition the superintendents and most of the older foremen have been given endowment policies.

Retirement plans are usually worked out on a scale which varies with length of service. The plan of the Colorado Fuel and Iron Company, which is typical of the best-developed retirement plans, provides for the retirement of all employees of sixty-five (women, fifty-five) after twenty years of service, or the retirement of employees of sixty (women, fifty) after thirty years of service, with certain special provisions for others.

The retirement payments are 30 per cent of the average pay per month of service during the ten years next preceding retirement, with a minimum of $20 per month. The plan is in charge of a Service Retirement Board consisting of five officials of the company, who have discretionary power to retire others than those affected by the major provisions, as for instance, employees who become physically incapacitated for service.

Co-operative stores. Companies which manufacture articles of wearing apparel, or other articles which employees are interested in purchasing, usually maintain retail counters or stores at which employees may purchase the product at cost of manufacture. Other companies maintain retail stores for the purpose of selling groceries and other necessities. These are best operated on a co-operative basis, if criticism and ultimate failure is to be avoided. Frequently these stores will sell coal and other expensive necessities on the weekly basis. Articles are usually priced on a basis of cost plus handling charge, with inventories taken frequently and prices adjusted accordingly. Sometimes there will be an attempt to make a profit, with this profit turned over to the mutual benefit association of the plant. Some company stores remain open all day, as in the case of the Packard Motor Car Co. of Detroit, and the Multigraph Company, of Cleveland, either workers or their families being permitted to make purchases. Other stores are open only just before and after working hours and at the noon period. The Hood Rubber Company, of Watertown, Massachusetts, utilizes a box into which orders can be dropped. These are gotten up during the day and are ready for the worker when he calls for them in the evening.

Social betterment work. Social betterment work on the part of industrial plants is to be studiously avoided, unless municipal conditions seem to make it absolutely necessary. The only possible exception to this rule is in the case of companies which have determined suddenly to pay a wage much higher than that formerly paid, and higher than the community standard. It may in such a case be necessary to go into the workers' homes for a long enough period to educate him to the proper disposition of the additional wage that is paid. Large steel mills and textile mills in new industrial communities in the South at times find it necessary to at least temporarily branch into fields of social betterment, until local organizations can be formed to take over these phases of civic responsibility. Such work includes the operation of playgrounds for the community in general, charitable relief, settlement work, day nurseries, general clinics, boys' clubs, etc. Whenever it is deemed necessary because of general living conditions in a community, for a plant to enter into this class of work, it should do so with a definite, developed programme to withdraw as soon as possible.

CHAPTER XXX

EMPLOYEE TRAINING METHODS

In no other feature of industrial management is the size of the plant such an important consideration as in the organization and development of employee training. The size of the plant will often be the limiting factor which will determine whether this work should be undertaken, or, if undertaken, the scope which it may take. Training work, although usually valuable, is always expensive, and it will not prove profitable on a large scale in small organizations. By training work, reference is not made to the instruction of workers in methods of performing particular tasks, but rather training of a character which is general to the trade or job. In every organization, foremen, department heads, or specialists, such as time-study men, must instruct the workers in the performance of specific jobs. Such instruction merely warps the previous training and experience of the worker in a way which will enable him to perform his tasks more effectively. Such training is a portion of the supervisory process and must be always carried on.

Inexperienced workers are continually applying for employment in tasks which require experience. Frequently these may be eliminated by the employment department, but often they must be hired and tried because of the necessity for and scarcity of workers. And often workers, generally skilled in the trade, must be trained in the particular branch of the trade, if spoiled work, disabled machinery, or accidents are to be reduced to a minimum. Then there are great potential gains in training workers, already employed, for advancement, and in training foremen and departmental supervisors toward a better understanding of the company and their jobs. These are the phases of a general training programme, and they must always be developed with the present and prospective size and general policies of the organization foremost in mind.

For industry as a whole, the days of apprenticeship seem to have definitely passed, and yet, with better production and management methods there has developed the necessity of having definitely competent workers on production jobs. Under modern industrial conditions, knowledge of materials, knowledge of machines, and knowledge of processes have become more important, as knowledge of the handling of tools has become less important.

Apprenticeship-training. Apprenticeship in its older forms has largely passed from industry. The increasing opportunity that lies before a young man to gain a relatively large wage in a short period by learning to operate semiautomatic machinery has been the cause. He will no longer consider binding himself out for a period of years at nominal wages in order to learn a trade. The growth of educational opportunities has partially absorbed that proportion of the younger generation which might otherwise be sufficiently forward-looking to take up apprenticeship-training. Such training is found to-day only in the larger plants, which, because of the large number of all-round workers that they need, can afford to introduce training courses and stand the expense of training workers who may not remain with them. Thus, such companies as the Westinghouse Electric and Manufacturing Company, the Goodyear Tire and Rubber Company, the General Electric Company, and the Ford Motor Company have found it profitable to develop apprentice courses. In these are enrolled young men and boys fourteen to eighteen years old, or more, who are trained for three or four years, paid wages for hours of instruction, as well as hours of production, and then at the end of that time are graduated as qualified journeymen and given $100 or $150 and their kit of tools. Companies in other industries have given freely to trade schools, which give the equivalent of an apprenticeship-training, as in the case of the textile industries of New England and the textile schools there.

Vestibule schools. Most plants have not been able to afford to introduce apprentice-training on a large scale, although some have been able to train a few apprentices from time to time, particularly if their work be unusually skilled. Most industrial training has recently taken the form of training for the task rather than for the trade. One of the more recently developed forms of such training is the "vestibule school," which teaches operations rather than principles. This is a preliminary training shop specially designed for instruction, through which new employees are taken before being allowed on the production floors. It came into particular favor during the war period of 1917–20, because of the large number of workers who were engaged in occupations with which they had been previously totally unfamiliar. Sometimes this training takes place in a separate room and sometimes in the corner of the actual production floor, which is somewhat better where feasible, since it makes possible the immediate acclimatization of the new employee to the shop atmosphere of production. This same consideration makes advisable that whatever work shall be carried on in the vestibule school shall be a part of the regular production, turned out on regular machines. It must, of course, be a kind that is suited to beginners, but the regular standards of quality should be adhered to.

The Norton Company, of Worcester, Mass., manufacturers of abrasives and grinders, have developed a satisfactory training system of this nature which provides a six-week course for machine workers under the direction of a special director of training. They feel this has made for better workmen at less cost of accident, production, and turnover than would be secured by other methods. The cost per man, over and above production of such training, is around $70 for them, an amount which they consider to be far less than if the man were allowed to go directly into the shop. In addition, they utilize this school for training workers who wish to learn the operation of machines other than the ones they have been working on.

The vestibule school has fallen into great disfavor since the war period. There are times when it seems to be the best type of training, as when the job is unusually hard to learn, as contrasted to similar jobs within the industry, or when instruction seems to be impossible in the shop because of unusual conditions of production. However, it has many disadvantages. No matter how great the attempt, it is difficult to reproduce actual working conditions. It is difficult and expensive to have sufficient machinery of each type in the plant set up in the school for instruction purposes. Because of the uneven demand for new workers, either part of the vestibule school is usually idle or workers are rushed through it without the desired training.

Training the worker in the shop. Most forms of employee-training involve his instruction on the production floors while engaged in the regular processes of production. In training in this manner, no additional equipment is necessary, but it is essential that the work be constantly checked up to insure that training is actually carried on. Such training is either by or under the immediate supervision of the foremen. This is an ideal method of training under modern industrial methods, because the foreman, having been relieved of many of his previous duties, is left free for supervision and training work, his logical field. All foremen are not inherently successful teachers, but if they have as complete a knowledge of their work as may be expected of them, they may themselves be readily trained to impart their knowledge to others. This may be done by whoever has general charge of training within the organization. Foremen are often aided in instruction of beginners by an assistant particularly designated for that work, in case of large departments, or by designated workmen in smaller departments. Under the latter method it is necessary to reward the worker for giving the instruction. Success will usually follow training under the foreman, if it be made clear that this is one of his chief duties, and if means are provided of following up workers to see that they are, in fact, receiving training and are not being left to drift.

Training for promotion. Any promotion programme which may be adopted by a concern cannot be allowed to rest with the development of lines-of-promotion charts. This is particularly true of promotion from one shop job to another. Means must be provided to allow for the training of deserving employees in tasks that are higher on the promotion scale. With the vestibule school this may be accomplished readily, and of such a programme allows for the utilization of this school during times that it might otherwise not be busy. Without the vestibule school there is necessary a thorough education of the various foremen in the desirability the programme, and a continuous follow-up, by means of accurate records, to see that employees who are in fact successful are being prepared for advancement by their supervisors along the lines which have been laid down by the promotion programme.

Training subexecutives, foremen, and supervisors. Subexecutives hold a new and very important place in industry to-day. Upon them devolves the task of directing wisely the huge mass of industrial workers. To them these workers look for guidance and for an interpretation of the policy of the company. Much can be done to train these men for their tasks merely through the method of organizing the enterprise, as was explained in considering the committee idea in organization.[1] Much more can be done through intelligently handled plans of foreman and subexecutive training. Such training must primarily aim to develop the qualities of leadership of the foreman or subexecutive. It must broaden him, and at the same time must develop such qualities of analysis within him that he may be able to visualize his job as he was unable to do previously, and as no training course can enable him to do. One of the most important aims of such training must be to so develop the foreman that he will be able to find ways and means of winning the confidence of those under him to an extent far beyond his previous ability. Regardless of the formation and operation of a personnel department, which will endeavor to win the complete confidence of the working force, it is but natural that a large proportion of it will continue to look to the foreman as the means of contact with the firm. Thus, the foreman will be likely to occupy a natural place in the esteem and confidence of the workers which cannot be duplicated by any artificial relationship which it may be attempted to establish. Workers, particularly men, will confide to a foreman matters concerning their home affairs that will enable him to better exercise his supervisory authority and to dispense supervisory justice, providing he has won their esteem. But to properly evaluate this information and to consider it along with the requirements of the concern necessitates both the power to analyze and actual knowledge of broad company policy.

Foreman and subexecutive training should result in furthering the

[1] See Chapter. V

ability of these members of the organization to analyze themselves and to see better wherein they are living up to the important trust which has been placed in them. It should result in encouraging the subexecutive to see the plant as a whole and to see his relation to it. Furthermore, it should so develop these members of the organization as to qualify them for advancement to positions of greater authority, as these become available.

But caution must be exercised in the methods of training which are used. Subexecutive training is another one of those management ideas which has been both grossly over-used and grossly misused. The training must be carefully developed, lest it result in the swelling rather than the growing of those who are being trained. This is likely to result from too much unstinted reiteration of the great importance of the subexecutive to the business. Some types of men can listen to discourses of this kind for a long while and still see relationships. Others will merely go back to the shops more fully convinced than ever of their own importance. Furthermore, if the inducement of advancement is held out by the firm as the bait to attract the subexecutive to the training, there is likely to be much disappointment when it is realized that for every possible promotion that may exist, there are now a number of trained candidates. Last but not least, managements must be careful that they do not encourage the enrollment of their subexecutives in training courses which advocate policies which the management is not ready and willing to see carried into effect. This is particularly true with that type of training involved in courses that bring together foremen and department heads from a number of plants and which take up the more advanced phases of management technique. Foremen, particularly, who receive this training and who find themselves both unable to advance to higher position and unable to put into effect the methods which they have learned, are likely to develop a very bitter attitude toward those higher up in the management. They are soon likely to feel that it is the management, not they, who needs the training.

There have been two general types of subexecutive training developed, that which provides for discussions of methods, policies, and trends by the supervisory force of one plant at meetings held at the plant, and that which provides for enrollment in general groups of supervisors from a number of organizations. The first plan is by far the more desirable, where it can be adopted, but small concerns, located in large industrial communities, will find much to attract them in the latter method. In the one-plant groups there is an opportunity provided to relate all discussions to the problems of the plant and the individuals who compose the group. Where such groups do not provide the training which it is desired that any particular supervisor have, such person may be individually advised to join some general group, or some particular home-reading course,

or trade-school or evening course. However, to secure benefits of real training it is essential that any groups organized within the plant be very homogeneous, in order that topics which are of direct interest to all may be discussed. Several training groups may well be organized. If large groups, composed of all executives, are to be formed, it is necessary that the material discussed be confined to general matter, or matter that involves the co-ordination of activities of nearly all those present. Such plant groups can often be handled to best advantage as a part of a foreman's club, or some such activity. However organized, it is essential that attendance shall in fact, as well as in theory, be optional, although, once organized, it will be necessary for the leaders to take every possible step to insure good attendance. This can best be done by making all meetings snappy and full of interest, but it also can be aided by the development of incentives of some nature. These need not necessarily be cash bonuses, but may be return of a payment for the instruction if a certain percentage of attendance be reached, or may involve extending certain privileges for further training.

Group training courses which are open in varying amounts depending on the size of the town in which the plant is located, and which may be recommended by the management, include Y.M.C.A. courses, university evening and extension courses, and courses maintained by groups of plants acting jointly. Examples of the last class will be found in the very complete training programmes for subexecutives which have been provided by the Industrial Associations in Cleveland and Philadelphia.

To involve real training, any course should require some work outside of the time of actual meeting. If too much work be required the course will not be successful, but real training involves more careful thought than can be given in an off-hand discussion. This refers particularly to general subjects, such as foremanship problems. Of course, more technical courses, such as a course in shop mathematics, involve preparation without question. The more discussion, the more those in training will benefit. In one plant a foreman, who was always known as taciturn and unwilling to discuss his problems with anybody, surprised the assemblage one evening by holding them spellbound for two hours on the work and importance of his department. Such long discourses are not to be encouraged, but this indicates how growth is inherent in subexecutive training. Discussions should be carefully led and confined to the subjects at hand. Lectures, particularly if they are illustrated, are valuable at times, but can be dreadfully overworked. Although either men from within the organization or outsiders may have a valuable point of view to present which should be included in the training, no course of instruction should be organized on this basis. Even with discussions following the

lectures, such a plan is likely to result in diminishing attendance, diminishing results, and no real training.

The more intimate the subjects of discussion, the more valuable will be the results. The accompanying chart (Fig. 69), illustrates the type of subject which makes for progress. It was worked out during a conference of foremen at the plant of the Everett Pulp and Paper Company, Everett, Washington. It represents the amount of supervision, on a scale of 10 as complete, that should be exercised by the foreman over the operations performed by the digester man in the pulp mill. The heavy line connects the amounts which the particular foreman thought were necessary before discussion, and the dash line connects the amounts which were finally agreed upon by him as correct after discussion and

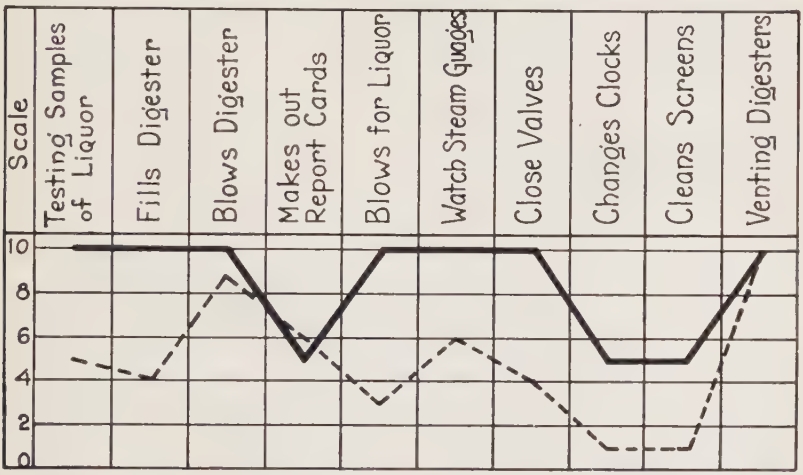


FIG. 69.—Chart Showing Relative Importance of Supervisory Duties, Everett Pulp and Paper Co., Everett, Wash.

argument. Such meetings, if properly led, will result in real foremanship training.

Supervision of training. In large plants, all training may well be placed under the direction of a supervisor of training, who may report to the director of personnel. In smaller plants, direction of training will probably be placed under the employment department or the service department. At any rate, it is largely a personnel function, although it deals so intimately with production. In it are involved numerous major relationships of the management and the workers, including fitness for the job, promotion, and interpretation of plant policy. As such, it is primarily a personnel function, at least, to the extent of follow-up. Actual instruction may well be in charge of the actual production force, as has been indicated.

CHAPTER XXXI

EMPLOYEE PARTICIPATION IN MANAGEMENT

Growing apace with the personnel movement in industry has developed one of its most important adjuncts,—employee participation. Participation has meant at times a share in the profits of the enterprise, but more correctly, and increasingly, it has meant an employee voice in the determination of management policies, insofar as they affect employee interests. To thoroughly understand the evolution of this idea in industrial operation, it is essential that it shall not be regarded wholly in the light of the structure of any one of its forms of expression. The form is not important. The basic idea is. There has never been found as great an incentive for carrying on industry as private ownership and the sense of private property owned or to be acquired. Employee participation in management seeks to extend to all members of the enterprise such a share in its operation that the urge of private ownership will be extended throughout the working force. Whole-hearted advocates of employee participation feel that workers will have no more interest in the business than the plant allows them economic interest. They feel that the solution of the destructive effects of strikes and lockouts, including the uneconomic compromised results of these, can only be found in arousing, by participation, a sense of partnership in the enterprise within the minds and hearts of all its employees.

Employee participation in profits. The first and oldest form of employee participation is direct financial participation in the profits of the business. This may come either through some developed plan of profit-sharing, or through melon-cutting at the end of prosperous years. Profit-sharing implies an agreement between the employer and the employees, under which the latter receive, in addition to their wages, a predetermined share in the profits of the undertaking over a given period. Under profit-sharing, an employee knows at the beginning of a year that he is going to secure a very definite share of whatever profits there may be at the end of a year.

The distribution of bonuses at Christmas, or other times of the year, in the attempt to share with employees the profits of the enterprise over the period, has not usually proved a successful form of employee participation. It cannot in reality be called participation at all, since the dis-

tribution of the bonus is essentially a gift from the firm to its workers. There are cases in which bonus distribution has resulted successfully, but in these the bonus is generally regarded as a portion of wages, paid in a lump sum.

Profit-sharing is often used as a means of arousing the interest of workers whose work is such that it is difficult or impossible to place them upon piecework. Such men are executives, delivery-men, men in the shipping room, and, at times, salesmen. Then again, by arou ing the sense of participation, profit-sharing is frequently used for some specific purpose in the business. Thus it may be used to prevent the waste of materials, as in the case where a concern agrees to split " fifty-fifty " with its employees any saving of material which is effected by them. It is regarded by many managers as an ideal way to reduce labor turnover, by providing that only employees of a certain minimum length of service shall share, and that these shall share in accordance with their length of service. Profit-sharing becomes an ideal preventive for hasty strikes called without warning if it be provided in the profit-sharing agreement that only those employees with continuous service shall share in the profits. Going out on strike is naturally interpreted as interrupting continuous service.

One of the main objections that employers have raised to profit-sharing, is that it does not in reality involve financial participation, inasmuch as losses are not shared by those who share the profits. This unquestionably is one of the weaker points in any profit-sharing-plan, but its importance varies with the basic thoughts which have prompted the plan. Thus some employers have come to feel that there is a wage for capital, just as there is a wage for labor, and that, in justice, all above a certain wage for capital should be distributed between capital and labor. Under this assumption, there would be no cause for workers to share in losses, provided only that some provision were made for their repayment prior to the workers again beginning to share in the profits.

An example of a successful profit-sharing scheme is that of the Arco Company of Cleveland, Ohio, manufacturers of paints, varnishes, and enamels. Their plan has been developed on the idea that the share in profits should be wholly apart from wages or salary, except that these may be taken as a basis for apportioning the amount distributed. Employees participate after one year's continuous service, at the end of which time the company pays into a fund, to the credit of the employee, a sum equivalent to 5 per cent of the salary or wages (not in excess of $3000) received by him during the twelve months immediately preceding. After the first year of continuous service, the company increases each year by 1 per cent the amount of its contribution until 10 per cent of his salary not in excess of $3000 is reached, with the proviso that the employee pay into the same fund an amount equal to 5 per cent of the wages or salary paid him during

the previous year, but not over $150. Thus the company pays at least 5 per cent as a share of profits to employees of over one year's standing, and will pay an increasingly greater percentage for the next five years, providing the employee also pays into the fund a share of his salary. All moneys paid into the fund can be withdrawn by the employee, without question, after ten years of continuous service, or after three years by a woman employee who leaves to get married. Employees leaving before this time may withdraw all their contributions to the fund and in addition certain percentages of the company's contribution, ranging from 55 per cent after the first year to 95 per cent after nine years, the percentages between increasing by 5 per cent each year. Thus, length of service is one of the most important factors in sharing the profits. Profits are further shared by the investment of the funds available through this plan in the stock of the company, and the payment of dividends to the owners thereof.

Employee stock-ownership plans. This feature of investing profit-sharing funds in stock of the corporation is coming to be one of the more usual features of profit-sharing schemes. It thereby leads to direct participation in management. Any such plan must be carefully guarded and explained to employees concerned, particularly as regards possible decline in market value of the securities. Furthermore, unless the number of shares which a given employee may own is considerable, the plan tends to become one for investment of the surplus funds of the employee, rather than one of participation in management. This is indicated by the tendency of employees to sell stock, if it be in their control, at times when the market begins to decline. Stock-ownership plans are more successful as means of participation among salaried officers than wage-earners, as these are usually better able to see and understand the benefits and are usually in a position to own sufficient stock to arouse their enthusiasm for the scheme.

Employee representation-works councils. Real participation in management can usually be achieved better and without any "strings" by some form of worker-representation than by any form of financial participation. The object of employee representation is to substitute co-operation in operations for the antagonism that has been frequently felt necessarily to underlie employer-employee or management-employee relationships. Co-operation can be achieved frequently without employee representation, but this is presumed to furnish a condition wherein co-operation is enforced on both sides. It provides a condition wherein either side will perforce get co-operation out of their relationships with the other, if they put it in. Usually co-operation follows confidence, and confidence comes easily if management shows representatives of the workers that both it and the employer have the interests of the employees at heart. It frequently is necessary that a period elapse before employees are convinced

that the employer is sincere in providing employee representation. Then a longer time is often necessary, after the plan has begun operating, to convince both sides that their interests are similar as regards effective operation of the plan.

Works councils provide for representatives of the employer and those of the employee getting together and discussing matters of common concern. They are formed on the basis of agreements between an employer or a management and the employees of that business, and differ from trade agreements, or agreements between an employer or employers in a given industry and organized workers within the industry as a whole. Trade agreements will be discussed later. Works councils always consider questions of shop rules and grievances, and in addition they often handle questions of efficiency of operation and economies, and at times questions of policies. Works councils organized for the first of these purposes are likely to develop so as to consider the others.

Participation in the framing of shop rules and in the settling of grievances which arise in the ordinary course of operations is a logical field for the works council. Here are the phases of management that most directly affect the worker's working conditions, and here are the points where restrictions are most likely to cause him to have an adverse attitude toward the management. Most points which come up are small from the standpoint of the management, but important from the standpoint of the worker.

It is these matters which, if the workers have no voice in their determination or settlement, are most likely to make them feel that they have no real interest in the business or in its productivity. On the other hand, if, through representatives, these are handled by joint action of the employer and the employed, full and complete co-operation of all will usually be secured. The adoption of rules which the large majority of employees believe to be unfair cannot benefit an enterprise, and such rules cannot pass when works councils must do the passing. On the other hand, such rules as are fair will be enforced through the works councils, and enforcible penalties which have the support of the large majority of the employees will be provided. Through works councils, grievances will be aired and settled without delay and will not be allowed to be running sores that may readily turn into cancers of industrial strife. Most grievances are petty matters which allow of easy settlement, whereas uncorrected grievances soon come to be looked upon as an evidence of the general attitude of the company. The works council will provide an organized channel through which these grievances may be brought up and promptly considered. For instance, the workers of a given department may feel that the time clock is inaccurate or needs repairs, and the foreman may not take the prompt action which they think is needed. If no

means of airing such a grievance be provided, it can readily be interpreted as meaning that the firm is not desirous of having the workers earn the bonus which may be offered, and may thus be interpreted readily as an evidence of basic policy. With a shop committee or works council before whom the matter might be brought, the time clock would without question be immediately repaired.

If the power of works councils be extended beyond mere routine consideration of rules and grievances, they may well handle, together with the personnel department, matters of discharge. Rules relating to causes of discharge may be formulated by the works council and then administered by them. All cases where, after conference between the foreman and the personnel department, discharge has been decided upon, can be brought before the works council for consideration upon request of the employee affected. Such power, if granted, will do much to make the workers feel that they are indeed partners in the enterprise, but nevertheless such power must be granted only after the co-operation of the foremen has been secured, or discipline will be likely to suffer. With good foremen, the restriction upon their authority will not be likely to be important, because they will still have the power of administering any rules which have been laid down by the works council, on which they will be represented in some way, and proper administration of these rules will ordinarily be upheld every time. It is not necessary for the maintenance of discipline that it be unfairly administered, and it is only such cases that are likely to be affected.

If the powers of the works council are to be broadened, they may well include matters concerning settlement of base rates. That changes in rates and schedules of hours to be worked can be made without friction has been the experience of those plants which have submitted such questions to their works councils for decision. In fact, many plants have found that when a reduction in rates is necessary, the works council provides the most satisfactory means of explaining these to the body of workers. It is easier to convince a small group of workers of the advisability of rate reduction than it is to try to convince a huge body of workers. Once convinced, the workers' representatives can usually convince their fellow-workers in short order. Experience has indicated that workers are perfectly reasonable about such matters as wage reductions, if shown the necessity for them, and if consulted concerning the way they should be put into effect. In cases where layoff is necessary, the works council provides the most satisfactory method of determining just which workers should be affected. Some plants have developed the idea of presenting to works councils such matters of basic policy as the production schedule, inasmuch as this directly affects the amount of work to be available. This would certainly not be advisable until the works council had been in opera-

tion for a long time and an experienced group of workers' representatives who could appreciate the manufacturing and economic conditions involved were members. Works councils may well consider routine matters relating to production, such as quality, scrap, safety, and general working conditions, when there are no grievances or special matters for attention at the meetings. To be effective there must be regular meetings and not meetings called at long intervals, and these subjects form a satisfactory fill-in for the discussions.

Types of works councils. The three main types of works councils which are utilized are the " industrial democracy " type; the " shop committee " type and the company union. The Industrial democracy type of works council attempts to apply to industrial organization a method of passing laws and settling policy which is similar to the organization of the Federal Government. There are ordinarily three bodies provided as parts of the works council under this type. First there is the House of Representatives, which is composed of representatives of the workers, then there is the Senate, which is composed of representatives of foremen and department heads. Finally there is the Cabinet, or representatives of the employer, usually major executives. Matters to be settled may be brought up first in either the House of Representatives or Senate, in the form of a bill, and after the bill has been passed by both houses, it goes for approval to the Cabinet, where it may be accepted or rejected. If rejected, it goes back to the house which originated it for revision or abandonment. This plan, sometimes with modifications, was, in 1922, found installed in about forty manufacturing concerns in the United States.[1] It has the advantage of clearly bringing in the department heads in the formulation of any decision, but is very unwieldy, and has sometimes been installed in a way which indicated that the firm was turning over considerable power of administration to the employees, which, in fact, is not the case, inasmuch as final veto rests with the employer's direct representatives. It has been discontinued in many plants where it has been set up and a simpler plan substituted.

The shop committee plan involves the selection of certain members of the works council by the employees and selection of certain members by the employer. These members usually sit together and their decision is usually final. If they fail to reach a decision, the conditions of the plan usually provide for an appeal either to a major officer of the company or to a neutral arbitrator. Under this plan there may be one committee for the whole plant, or there may be departmental committees selected by the workers of given departments. Departmental committees consider minor matters, such as grievances, with representatives of the employer,

[1] Research Report No. 50, "Experience With Works Councils in the U. S." National Industrial Conference Board, pp. 185–191.

and select workers' representatives to sit on the works council, which is an appellate body for such minor matters and a body of original jurisdiction in the more important matters that are considered. The one-committee plan is utilized in most small plants and many large plants, such as the Colorado Fuel and Iron Company (who have a general council composed of workers from the several plants). The divisional committee idea, coupled with the main shop committee, finds preference at large plants, such as the plant of the General Electric Company at Lynn, Massachusetts, which was one of the first to establish shop committees in the United States. In 1922 there were about 150 plants in the United States using some variation of the shop committee form of works council.[1]

The company union provides for the selection of employee representatives from among the members of some association of workers within the plant, such as a beneficial association. Workers who are not members of such association are not usually represented under such plans. This has the tendency to cause workers to join organized bodies of fellow-workers, hence the designation, "company union." Since there is usually a tendency for the organization to take over all phases of activity ordinarily carried on by the labor union, this form of works council has received the most violent opposition from organized labor, although, as will be shortly seen, organized labor is, in the main, opposed to any type of works council.

Operation of works councils. The exact organization, qualification of voters, term of office of representatives, number of meetings, and other routine matters will naturally vary with the necessities of the particular organization and with the desires of those forming the works council. There are, however, some general conditions which seem to be tried and applicable in almost all cases. Voters for employee representatives must usually have been in the employment of the company for a certain specified period, usually about three months. Employee representatives' qualifications are well illustrated by the provisions in effect at The Intertype Corporation, Brooklyn, N. Y.: "Every qualified voter twenty-one years of age or over, who speaks and writes the English language and has been continuously in the Corporation's service for one year prior to election shall be eligible as an Employee Representative from the department where he works." The term of office of representatives is usually a year, with provisions, such as those at the White Motor Company, Cleveland, Ohio, which cause the elections to be held at different times, and thus make impossible the entire overturn of a committee at once. Meetings are held at periods varying from one week to a month. In the successful plans the meetings, when called, are uniformly held, and are conducted as serious occasions.

[1] *Ibid.*, pp. 185–191.

Most plans call for an equal division of voting strength between the employees and the employer in all cases except the Industrial Democracy plans, where this same feature is provided for in another way. Usually it is necessary to pass actions by more than a mere majority vote, sometimes by a two-thirds or three-quarters vote. This provision makes for permanence in the decision reached, but it also causes a certain number of cases not to be settled by the works council, and thus makes important the final authority. Regardless of the provisions for final authority in actions of the works council, it is necessary that the general management keep itself informed of what is going on and take an active interest in the proceedings. If this does not occur, the works council is bound to fail. If the general management does appear interested in what is going on, the members of the works council are likely to see the importance of their position and their work, and are likely to settle cases in a manner which is more satisfactory to all. Final authority is sometimes lodged with a member of the general management, this being the most usual method. At times final authority is lodged in some previously agreed-upon arbitrator, such as the department of labor of the state, the state chamber of commerce, the Department of Labor conciliators in Washington, or some local person who is respected by all parties. If such final agreement is lodged in an impartial arbitrator, some schemes provide for a previous consideration of the case by a representative of the general management of the plant. If his decision is not favorable to the workers, the appeal to the arbitrator can then be made. In all cases where an appeal to an arbitrator is made, his decision is always regarded as final. However, some plans specifically provide that his decision shall not limit the right of the employees to strike. That such right would rarely be utilized after the procedure just described had been gone through is evident.

Some plans have provided that the eligibility of a worker to be elected as a representative in the works council shall not be limited because of his membership in a labor union or other organization. In only one or two cases has there been any evidence of a labor union attempting to utilize the works council to further the organization of workers within the plant. In general, labor unions have refused, as organized bodies, to have anything to do with works councils, and in some cases, all but highly organized departments of a plant have accepted the works council, with no representation from the organized departments, who have continued to work through the regular union officials. The 1919 convention of the American Federation of Labor, held at Atlantic City, condemned works councils as a delusion and a snare, and "set up by employers for the express purpose of deluding the workers into the belief that they have some protection and thus have no need for trade union organization." This is characteristic of the general attitude of organized labor toward works councils, but the

National Industrial Conference Board, in their study of this question, were unable to decide the extent to which organized labor had actually interfered or attempted to interfere with the organization of works councils.[1] In general, it is clear that a works council will not be effective if it be organized in times of stress, when the workers are dubious of the attitude of the management and perhaps are about to strike. The workers naturally become suspicious when they see the shop committees being organized at such times because of an overnight zeal on the part of the employer for "industrial democracy." The time to establish a works council is in fair weather.

Justification for the labor-union attitude toward the works council may readily be found if the employer, by establishing it, hopes to be able to swing its deliberations in a direction which will be favorable to himself. If the expressed purposes of founding the works council are not actually those in the minds of the employers and management, the council may better be left unformed. If the management has not come to be convinced that participation of the workers in the management of the plant is desirable, it is far better to operate on a policy of fair dealing without a works council than on a policy of camouflage with one. Labor unions are right when they say that in the last analysis the effect of a works council on the individual worker rests on the attitude and fairness of the employer. This is true with all devices of management, and particularly with one in which the management is ostensibly turning over the control over portions of their operating and policy-developing fields which have always been theirs. Thus the works council itself does not become a cure for industrial ills, but, properly used, it may be made a very effective step in giving to the worker a feeling of partnership in the business.

Many managers have said that what the worker wants is not a partnership in the enterprise. What he wants is to be able to be certain of steady work at fair wages, with an opportunity for advancement. If he is given this, these managers say that he makes no demands on them for representation or participation in management. If a manager is sure of this, and if he is conducting his business in a way that attempts to make things fair for both the worker and the employer, it is very probable that, as yet, in that plant, it would be unwise to try the formation of a works council, and far wiser to continue the broad-minded policy of management along the old lines which have proved successful and satisfactory to all concerned.

Trade agreements. Trade agreements are contracts which are drawn up between an employer or a group of employers with an organized labor organization, covering some or all of the matters of common interest. Ordinarily trade agreements have not been sought by the employer, and

[1] *Ibid.*, p. 138*ff*.

have either been suggested or forced on him by the labor organization and general conditions within the trade. This does not mean that they have not been adopted with the full consent and co-operation of the employer. Some of the most successful instances of collective bargaining in the United States are found in the trade agreements. It does mean, however, that the agreements have originally had their inception in labor troubles of some kind, rather than in a desire on the part of an employer or a manager to extend to the employees of the organization a share in the management. The trade agreement rests on the idea that representatives of the employer and of the organized employees should assemble and discuss controversial questions, such as wages, hours, working conditions, and other basic employer-employee relationships, with the view of setting a scale that will be binding until changed by mutual consent in the plant or plants covered by the agreement. The relationship between the two groups of representatives becomes a contractual one, and the representatives bind those whom they represent to carry out the terms of the agreement. The fundamental consideration in the contracts is the wage, and the idea of trade agreements is predicated on the thought that the basic wages paid are largely fixed by the bargaining strength of the employer and the employee. The recognition of organized labor and its representatives which trade agreements involve is based, from the labor point of view, on the thought of equalizing the bargaining strength of the two parties to the agreement, and giving the workers as effective leaders as those representing the employer.

The background of any trade agreement is well expressed by the preamble to the Hart Schaffner and Marx Labor Agreement, as formulated by Mr. J. W. Williams, then chairman of its board of arbitration, in 1916: "On the part of the employer it is the intention and expectation that this compact of peace will result in the establishment and maintenance of a high order of discipline and efficiency by the willing co-operation of the union and workers rather than by the old methods of surveillance and coercion; that by the exercise of this discipline all stoppages and interruptions of work, and all willful violations of rules will cease; that good standards of workmanship and conduct will be maintained, and a proper quantity, quality, and cost of production will be assured; and that out of its operation will issue such co-operation and good-will between employers, foremen, union, and workers as will prevent misunderstanding and friction and make for good team work, good business, mutual advantage, and mutual respect. On the part of the union it is the intention and expectation that this compact will, with the co-operation of the employer, operate in such a way as to maintain, strengthen, and solidify its organization, so that it may be made strong enough, and efficient enough, to co-operate as contemplated; and also that it may be strong enough to command the

respect of the employer without being forced to resort to militant or unfriendly measures."

It is but natural that the growth of trade agreements should have occurred in those industries which were already the most highly organized; and the history of trade agreements during the last decade has been the history of labor-employer relationships in those most highly organized trades. Trade agreements have been notably utilized and notably successful in highly organized industries, such as hand-blown glass manufacture, pottery and shoe manufacture, printing and the manufacture of clothing.

Trade agreements provide, not only a minute description of basic wages, hours, working conditions, rules, methods of discharge, but often cover methods of performing operations, output to be permitted, and regulations concerning the introduction of new machinery into the operations. They provide a means of arbitration or interpretation of the agreement, and a means of providing for conditions which may arise during the life of the agreement and after it has been adopted. In the settlement of disputes they almost uniformly prescribe some neutral arbitrator.

Trade agreements are negotiated through representatives of the union who may or may not be actual workers in the plant or plants which the agreement affects, and officers of the plant, or of the trade association which represents the employers affected. Disputes are ordinarily handled by departmental or plant boards on which both the union and the employer are represented. They may then be referred to a board for the industry as a whole, or a regional board, if more than one plant be involved. Finally, there is some method of arbitration, as has just been noted. As a concrete example of the structure of a trade agreement, that of the Hart, Schaffner, and Marx Agreement will be described.

The Hart Schaffner and Marx Labor Agreement—a developed trade agreement. This is an agreement between Hart Schaffner and Marx, clothing manufacturers of Chicago, and the Amalgamated Clothing Workers of America. The union has in each shop a duly accredited representative who is recognized as the officer of the union having charge of complaints and organization matters within the shop. He receives and makes inquiries into complaints; and he also collects union dues. The shop superintendent represents the management in each shop. Each side has a number of deputies who have direct charge of the execution of provisions of the agreement in the interest of their principals. They have the power to investigate, mediate, and adjust complaints; and settlements made by them are legally binding on their principals. One of the deputies on each side is known as the chief deputy, and the statement of the chief deputy is regarded as an authoritative presentation of the position of his principal in any matter in controversy. The union deputy has access to

any shop for the purpose of making investigations of complaints. There is a Trade Board to hear cases which are not adjusted between the deputies. This Board consists of eleven members, all employees of the firm except the chairman, five being chosen by the company and five by the union, and so chosen as to be representative of the various departments—cutting and trimming, coat, vest, and trousers. Finally, there is provided a Board of Arbitration of three members, one representing the company, one the union and an impartial chairman. Although it acts as a court of appeal from decisions of the Trade Board, the main duties of the Board of Arbitration relate to matters of principle and the application of the agreement to new issues as they arise.

When a grievance arises on the floor of a shop, the complainant reports it to his shop representative, who endeavors to adjust it with the shop superintendent. If satisfactory adjustment is not made, the shop representative reports the matter to his deputy without disputing or arguing the case. The deputies concerned then endeavor to reach a settlement that will be just and satisfactory to all the parties in the dispute. If they fail to agree they file the case with the Trade Board, who hear all cases in the order of filing. All decisions of the Trade Board may be appealed within ten days to the Board of Arbitration. If agreeable to both parties, these appeals are frequently heard by the chairman alone. The majority decisions of this board are binding, but a rehearing may be granted on demand if the Board desires. The chief deputy of each party to the agreement is held responsible for the enforcement of decisions.

The agreement covers the following main points: rates, including piece rates, which are made and changed by a rate committee of the Trade Board; hours; overtime; preferential shop; working conditions; discipline; transfers; and layoffs. The agreement provides for a preferential shop. Whenever the employer needs additional workers, he first makes application to the union. If the union is unable to supply the necessary help, the employer may secure them in the open market. Should it at any time become necessary to reduce the force, the first ones to be dismissed are those who are not members of the union in good standing.

The future of trade agreements. Employers, as a class, have been antagonistic to trade agreements. They have felt that they result in taking the control of operations from their hands and placing them in the hands of those who are not only less qualified, but who resist the introduction of economies in manufacture which are frequently necessary to the survival of the enterprise. They have claimed that such agreements merely emphasize the gulf between employer and employee, and that the natural result of such agreements is continued industrial strife on an increasing scale commensurate with the increased power of the two larger groups involved. They point to the railroad and mining industries as

examples of this point. Organized labor, on the other hand, has, in general, set the accomplishment of trade agreements as its goal. It has claimed that the increasing strength of the employer in industry, due to the amalgamations, integrations, and consolidations which are continually occurring, makes the trade agreement necessary as the only protection of labor. In this lies organized labor's bitter opposition to works councils.

It is probable that, in organized trades, the trade agreement will increasingly come into being. With experience in its operation, it may be confidently expected that better administration of agreements will become a fact of the future. This will include a broader view by the union of the necessities of industrial management and operation, particularly in securing economies of production, and a broader view by the employer of the aims of the union. However, trade agreements are only applicable to trades which are highly organized and to plants within those trades where the workers would rather deal through their union representatives than directly with employers through works councils or some other form of intra-company collective bargaining. The individual plant, in most industries, which maintains the confidence of its employees, and particularly, which makes the wages and conditions of work equal to or better than the union standard, will probably continue to operate smoothly and in successful relationship to its employees without the use of trade agreements, or even without the development of any form of works council, except possibly a very loose committee organization. But such operation can only be based on a broad, intelligently developed basic personnel policy which has been formulated squarely on the idea of the development and continuance of good-will between the firm, the management, and the workers.

PART VIII

CONTROLLING OPERATIONS

CHAPTER XXXII

BUDGETING FOR ADMINISTRATIVE CONTROL

In the modern business world, the extent of control over operations determines in a large measure the profits of the enterprise. Control over the operation of a particular department of a business is difficult to maintain unless it is linked up with corresponding control over departments with which it must mesh in the drive toward business progress. The administrative budget provides the necessary means of supplying the co-ordination between department plans. The budget idea in business implies the thought of planning ahead, forecasting to-morrow and laying co-ordinated plans which will lead all major portions of the business along paths that will cross and diverge at predetermined points, so that the business will operate as a unified whole. Business foresight is largely hindsight, and thus administrative budgets must not only be developed by means of forecasts of business conditions as they affect the particular enterprise, but on the basis of past history, carefully interpreted. Business budgets are much more difficult of formation than are governmental budgets, since income and expenditures cannot be separated. Unlike budgeting for governmental work, a reduction of expenditures in a business may reduce the revenues directly. Thus, a reduction of an advertising expenditure may reduce the sales, and hence the income, while the reduction of a manufacturing expenditure may directly affect production, and hence the source from which income is derived. This added difficulty, which is an important practical element in the development of administrative budgets, is the most difficult of measurement when visualizing to-morrow during the process of budget development.

Aims of the business budget. Budgets are necessary for business control, since they provide for a careful item-by-item consideration of depart-

mental programmes. They become a check on unjustified optimism or pessimism of departmental heads, and they not only give a target, but a bull's-eye at which those in responsibility may shoot, and toward which those in charge of the major business activities may direct their control. Not only does the budget make possible the development of departmental programmes, but it is a means of saving over-expenditures in departments. To check leaks, it is necessary that they be recognized when they are seen. Preconsideration of items of expenditure makes possible the recognition of leaks, both at the time the budget is being considered and during the period of operations that it covers. The budget is also a means of eliminating the misdirection of assets through improper enlargement of facilities at the wrong time. If expenditures for plant enlargement are subjected to a careful survey of their purposes and their justification, with a realization of what they will mean in terms of expansion of sales and production, it is very likely that hasty enlargement plans will be eliminated, and assets retained to operate the plant in phases where they are already needed. Finally, the budget is an unparalleled aid in the development of a financial programme. Bankers are steadily and increasingly demanding more knowledge of operations and programmes than formerly. They are asking for information, not alone along lines of balance sheets, character, and capacity, but along lines of prospective operations. They are desirous of knowing when loans which they may make are going to be repaid, and in this connection they want the detail of commitments, of prospective earnings, and financial conditions in a way that a budget alone can give. In increasing numbers, bankers are going to demand the submission of a budget which will definitely indicate when loans are going to be repaid, with substantiating figures, at the time that application for loans is made.

Advantageous developments which follow the use of the administrative budget. All of these aims of the budget are achieved through the developments which always follow logically upon its adoption. There is immediately secured an unheard-of co-ordination of departments, particularly a co-ordination of the sales, production, and financial forces. This co-ordination not only can be made general, applying to the activities of the business as a whole, but can be reduced to a consideration of particular lines and items. Departmental schedules can be set up which will detail the lists of expenditures, with their relation to the various items of product, as well as to the business as a whole. Costs can be collected in a way that will mesh with the developed budget, and they may be used as a means of control, which is their logical field, rather than as history. Finally, a financial programme may be developed which will act as a chart to the pilots of the enterprise as they guide their business through the storms on the sea of industry. The budget eliminates much snap judgment on their part, such as that frequently expressed, " Overhead is too high—it must

be cut," following which there is a general slashing without regard to consequences.

The procedure for budget making. The procedure for budget development usually starts with a preliminary conference of department heads, in which the trends of the business and of industry in general are considered, and broad lines of progress are mapped out with the aid of the general manager and others who have control of the broad policies of the business. With the results of this conference in mind, the departmental heads go back to their separate fields, and prepare budget estimates which are based on the general programme that has been outlined. These budget estimates are usually submitted to one officer of the company who has been chosen for the purpose. This man will ordinarily be the comptroller or the assistant to the general manager. In small businesses he will be the general manager. He suggests changes to the department heads, based on his knowledge of basic factors, and with an idea of coordinating the activities of the various departments. With this in view, he may call conferences of two or more of the departmental heads, whose estimates must depend on each other and who may seem to be furthest from agreement in their first estimates. When such matters have been adjusted to the fullest degree by this means, the general budget meeting is called, at which time each department head submits his budget, and must meet the criticism and comment of the others present. Although final control of the budget estimates must necessarily be left in the hands of the president or general manager, this budget meeting will ordinarily largely determine the final status of the budget requirements and estimates of the various portions of the business. When finally determined, the budget should be prepared in a satisfactory form and distributed to all interested persons, in order that they may know definitely what is expected of them.

Methods of making up departmental estimates—sales department estimates. If the preliminary budget shall have accomplished its purpose, it is probable that most of the budget items will be settled, at least, as far as their major outlines are concerned, in the development of the departmental estimates. It is, therefore, desirable to see how these may be prepared. The sales department estimate will first be considered. This will include a full statement not only of necessary expenditure but of probable sales and shipments during the budget period, subdivided by kind and unit value as well as by total value. The estimate of shipments is equally important with that of sales, as upon this will largely depend the time when cash receipts may be expected. This estimate must be based on a consideration of past history, as well as a full consideration of the seasonal factors that may be involved, business and competitive conditions in the industry, the obsolescence or style factors which may be

present, traffic conditions, and the relation to the manufacturing programme, both as regards production needs and the extent of unfilled orders. In taking into consideration these factors, the first step should be a careful charting of sales during the past, with an investigation of causes of irregularity. Trade association reports, reports of salesmen, and forecasts of general business conditions must then be studied, and a conclusion reached as to whether sales are likely to advance or recede from the normal amount of the period, after which sales may be estimated for the budget period. This estimate is basic in much of the budgeting work of this and other departments, and should usually have been largely determined in the preliminary budget conference. The trend of raw-material prices must be carefully observed and studied if these estimates are to approximate what the experience will be.

Manufacturing department budgets. If standard articles are being manufactured, the number in each unit of time during the budget period may properly form the basis of the manufacturing budget, with all expenditures dependent on this. If, however, the concern works to customer's order, or is largely influenced in the exact amounts of different lines or styles that it manufactures by the day-to-day demands of the market, it is probable that the manufacturing schedule must be worked out in terms of units of material or of cost. The manufacturing budget must be determined not alone from the estimated sales, but from the requirements of the manufacturing departments. That is, the attempt must be made to run the plant on as even a keel as possible the year round, and the manufacturing budget must be developed with this in mind, as well as the sales department estimates and the financial requirements of the plant. For, regardless of the desirability of equalizing the production programme in the various months of the year, this may not be entirely possible because of the style or obsolescence factor, or because of the financial inability of the concern to carry the amounts of materials and labor costs which would be thus tied up for months under such a programme. It is here that close co-ordination is necessary between the manufacturing and the financial departments, in order that every effort may be made by the latter to so finance the business that the manufacturing department may get all the advantages in lowered unit cost that are inherent in steady operation throughout the budget period. The unit costs of production under varying amounts of production need to be closely studied by the manufacturing executives in order that they may intelligently make recommendations concerning the spreading of the manufacturing programme over the course of the budget period, and they must be in close consultation with the purchasing agent, who, through his knowledge of the state of the material market, should be able to advise intelligently with regard to the probable trends in material costs, and with regards to the advisability of tying up large

amounts of the firm's capital in material, partly finished or finished product, on which return will not be secured for some time.

The estimated pay-roll can best be determined on the basis of the prospective production by carefully analyzing past pay-rolls at various points of production, and from these figures making allowances which are based on changes in wage rates or on changes in production effectiveness. A consideration of additional pay-roll costs due to overtime work, or due to the necessity of adding to the overhead, will often serve as a means of stopping sales expansion programmes which otherwise look good, with the additional costs of manufacturing to reach that programme eliminated.

Service department estimates. The budgets of the various plant service departments, such as traffic, shipping, and stores, may be included in the general manufacturing budget, or they may be developed separately, inasmuch as, like other service functions of the factory, the amounts of outlay are more or less constant, regardless of the manufacturing programme. The budgets of the general business service departments, such as the general office and the personnel department, should be closely capable of estimate and easy of preparation by the heads of these respective functions.

The financial budget. The financial budget cannot be prepared until the other major departmental budgets are in a fair way toward completion, inasmuch as it is directly dependent upon them. It should include a statement of the probable cash income and expenditures by months, and a careful analysis of the times at which the company will be compelled to borrow in order to carry on its manufacturing programme, as well as the times when it may be expected that the loans will begin to be repaid, and the times at which they may be completely repaid. The credit man of the organization will have a direct interest in the preparation of this information, and it will be his advice concerning collections that will make possible the translation of the items of shipments into receipts at a later time during the budget period. In order to be able to estimate receipts, he must be in a position to know the general credit situation and how money may be expected to come in. He must be able to advise concerning the terms of payment that will have to be permitted, and the extent to which it may be expected that the regular terms will be lived up to. In addition to this, he must be able to advise the times at which overdue balances will be liquidated. This information will largely give the basis, together with the sales department estimates, of the expectancy in receipts. From the other budgets, cash outlays must be determined through a consideration of such separate items as materials, direct labor, overhead expenditures, administrative and selling expenses, state and Federal taxes, fixed charges, and betterments to the plant. With the close analysis of all these items will come the possibility of formation of prospective balance sheets for various times during the forthcoming budget period.

With the final development of the financial budget, the budget plans of the business may be considered to have reached completion, and the various budgets of other departments may be looked upon as subschedules in the formation of the financial budget.

Length of the budget period. While the length of the budget period cannot be definitely stated for all industries and all plants, care must be taken, particularly in the beginning of budget development work, that the period does not extend beyond the time of possible accurate forecasting. It is necessary that some arrangements be made for periodical revisions in the budget, for reasons that are apparent, but which will be briefly referred to shortly. The decision concerning the length of the budget period must be dependent partially on the extent of information which is available concerning past operations. As budgets are prepared, and actual performance statistics are available to check against estimated figures, the length of the budget period may well be increased. General business conditions, that is, whether business in general is stable, or greatly unsettled, will also influence the length of time that the budget estimates should cover, and the number of revisions that must be made. In different businesses, the differences in the length of turnover of moneys and the importance of the seasonal factor will partially determine the length of the budget period. It should always be long enough to cover at least one complete cycle of operations, providing seasonal features and manufacturing to stock in anticipation of later sales are important factors in the business.

Action to be taken on the basis of the budget. Budgets are very largely valuable in proportion to the extent that they are used as the basis of action within the business. The general administrative control which is implied through the development of a budget implies that similar forms of control be carried through the whole business in each department. The success of the budget is, therefore, largely dependent on the extent to which each of the various departments has its work scheduled and analyzed. Thus, on the basis of the approved budget, the financial department goes to the banks and makes with them arrangements concerning the borrowing of funds to carry on the programme which has been adopted. The sales department sets quotas for their various lines, for their various branch offices, and for their various salesmen, and lets advertising contracts to the amounts specified in the approved budget, with a view of creating consumer demand which will enable it to sell the amount of each product that it has pledged itself for. The production department sets up general schedules of production, determines the activities of the various manufacturing departments at various times, and makes arrangements for the proper routing and despatching of the work through the factory in order that the basic schedules may be met. The extent to which such careful

departmental planning is carried on will be the measure of the success achieved in the whole idea of general administrative control. For instance, upon the effective setting of maximums of articles of stores may depend the accuracy with which the budgeted amounts of inventories will be reached and, therefore, the success of the whole financial plan that was developed.

Budgets, to be useful, must be flexible. Manifestly, if budgets are actually to control, rather than become a hoped-for ideal, they must be made flexible and changeable to meet changing conditions that may occur during the budget period. There are always some factors of the future that are incapable of being forecast at the time that the budget is prepared. These factors include minor changes in general business conditions, although major swings of the pendulum should be capable of being visualized, and changes in consumer demand. Changes in consumer demand may be basic, such as a sudden change from silk to woolen hosiery, which is influenced by the style factor, and which, while given consideration at the time of the preparation of the budget by the hosiery manufacturer, could not be evaluated as being so important as it later developed to be. Or these changes may be due to the unparalleled favor that the market seems to hold for one particular item or line of product, which causes it to suddenly become far more important than had ever been expected.

Changes of this nature in the budget may be made sometimes by the preparation of alternate budgets at the time that the budget was first adopted. Thus if sales vary by certain percentages, the sales department is informed ahead of time just to what extent it may increase or decrease its expenditures. If the costs of basic materials or of direct labor vary by specified percentages, definite predetermined authority may be likewise given the production departments to increase or decrease their expenditures in definitely stated proportions, and similar authority given the sales department to vary their estimated receipts from sales. It is usually more practical, however, to call for periodic revisions of the budgets when basic conditions change. The only danger in this is the possibility of department managers being given a loophole through which to escape if they cannot meet their announced budgets, regardless of whether there be a fundamental change in conditions or not. The budget is meant to be a bull's-eye, and is meant to enforce an administration of the several departments that will insure the budget figures being lived up to except in the most extraordinary circumstances. This must be kept in mind when steps are being taken to make the budget flexible.

The general manager may well have a chart constantly in front of him of the percentages by which each department is currently bettering or exceeding its quotas of production or expenditures as set down in the budget. If the budget is to be effective, he should constantly question

figures which are much out of line in either direction, and thus guide the department manager toward the bull's-eye, which has been made the objective of the business as a whole.

Limitations of budget control. Budgeting for administrative control has certain limitations which must be frankly recognized if disappointment from its use is to be avoided, and if the benefits which may be derived from it are to be secured. In budgeting, it is a slow process to approach perfection, a process that involves trial and error. The more frequent the trials, the fewer will be the errors. This must be understood by all executives, major and minor, or the budget plan is likely to fall into disrepute. Even if the budget figures are not capable of being fully lived up to during the first few years, the advantages gained from a careful consideration of all factors influencing the trend of the business, and the advantages of having the major executives sitting around with each other with all the cards of their various departments on the table should not be overlooked.

It must be understood thoroughly that budgeting cannot take the place of adequate executive control of operations, but is only an aid toward this. The effectiveness of the budget is directly dependent on the effectiveness of administration within the several departments. It is an influence which should lead to better executive control, but which can never replace it.

CHAPTER XXXIII

CONTROL OF INVENTORIES

Importance of inventory control. The business survival of an industrial enterprise may readily rest upon the effectiveness with which it controls its inventories. This is particularly the case if the purchasing function be considered a portion of inventory control. The stores and partly finished stock on hand often represent from a quarter to a half of the capitalized value of the business. Wastage, obsolescence, or poor purchasing may quickly wreck a concern through inventory losses. Poor control of materials is frequently accompanied by poor storeroom administration in a way that may easily throw out of balance any operation programmes which have been adopted. It seems almost incomprehensible, but it is true, that plants which have maintained accurate records of petty cash accounts totaling $100 have failed to even attempt to control accurately material accounts involving thousands of dollars. Such concerns operate their storerooms in such a manner that the only check on materials comes with the " taking of stock " or inventorying once each year.

If the business be budgeted, or if only sales and production programmes be adopted, it is essential that an inventory control be set up which will provide material as it is needed, and will not at the same time tie up large sums of capital which might be used in furthering the operating programme in other ways. No system of budgeting can be successful unless effective inventory control has preceded it. Otherwise production obligations cannot be met by the manufacturing department, at least within the allowed cost. Or perhaps the financial programme will be overturned through undue demands from the purchasing agent or interest charges on capital invested in material. The daily routine of cost accounting with or without an administrative budget, demands that material be accurately and intelligently controlled.

Sources of loss from improper control of inventories. The sources of loss from improper control of inventories should be carefully considered. They include the costs of excess purchases, the costs of slowing up production by not having material available when wanted, and losses through improper diversion of material, either wastefully or willfully. The losses due to excess purchases provide a continual pull toward small stocks and the losses due to production tie-ups provide a continual pull toward large

stocks. It is between these that a balance must be struck. The losses due to improper diversion of material necessitate the maintenance of adequate material records.

Excess purchases will bring with them not only the losses in interest and ability to otherwise utilize tied-up capital, but will bring with them direct loss from depreciation on the material and frequent loss from obsolescence, which may be so large that high-priced goods may have to be sold for the price of waste or junk. Good inventory control will prevent the purchase of materials except as they are needed, and will prevent the ordering of goods when large quantities are on hand already, or the ordering in quantities which are excessive. Particularly in standard products, graphic charts provide a means of eliminating expensive over-purchases. Over-ordering is costly on a stationary material market, while in a falling market, it may conceivably lead to bankruptcy. Damage and deterioration due to overstocking must be reckoned with. Excess quantities frequently encourage poor storing, with consequent damage to materials. Furthermore, many articles, such as foodstuffs, drugs and rubber, deteriorate with age, which may mean a total loss of all materials purchased above immediate requirements. One company manufacturing chemical products found, in instituting real inventory control during the depression of 1920, that they had sufficient of a certain ingredient to last until 1960 at the rate of use over the preceding few years. The losses incident to such a condition cannot occur with adequate inventory control.

To prevent slowing-down production, large stocks of materials have often been haphazardly purchased, thus bringing about the foregoing conditions. And yet if materials are not on hand when needed, manufacturing costs are run up to the sky and manufacturing programmes are shattered. To promote smooth factory operation and to prevent the piling up of idle machine time, proper material must be on hand when it is wanted. If material is not available in continuous process industries it may result in the temporary shutdown of a large portion of the plant. In any plant where operations, machines, and orders have been finely balanced, this will mean untold confusion. The storeroom is a service department, and quick, prompt delivery of materials to manufacturing floor or of finished goods or repair parts to customers is all-important. Furthermore, in periods of declining prices, where every urge is toward a reduction of inventories, customer service becomes of increasing importance, and the necessity for effective inventory control is enhanced.

Improper diversion of materials through excess use is a commonplace in many plants. It has been eliminated in as many others. Frequently material is thrown away, lost or damaged while in process, without any record providing a check. One textile concern recently stated that they only secured in finished goods two-thirds of the material which they put

into process, and while they thought they knew what happened to the rest, they had never investigated to ascertain the real conditions. When a workman sees that the management does not keep a close check on material, he does not hesitate to waste it or to dispose of excess in the easiest way. One cause of this condition is found if the plant allows excess material to remain in the production departments and be used on future orders, rather than to be returned to the storeroom. This is a common practice in fabricating plants where cartons of raw material, the product of other plants, are used extensively. In such shops, it will be evident that issuances are not checked in the storeroom or elsewhere against production orders, and thus standards of consumption are lacking. If the workman damages material, he can usually receive additional material from the storeroom without much questioning.

Direct thievery, although often important, is usually the smallest source of loss from improper material control. In some plants workmen have uncontrolled access to the storeroom. To allow this sometimes results in startling losses, especially if the material is of a type that is easily disposed of to pawn shops or to junk dealers. To protect materials from thievery is an obvious need of any stores system. Nevertheless, one plant allowed the storeroom to form the exit through which a number of the workers left the plant at night, their time clocks being located in the individual departments. The storeroom man made a practice of " beating the whistle," and the unattended storeroom was an invitation to theft which was accepted. The stock of small brass parts was always low until this condition was corrected.

Good inventory control which, together with good storeroom and purchasing department operating methods, can eliminate these losses, implies the following steps: (1) the fixing of minimum quantities, or ordering points, and of maximum quantities, or amounts to order, on all articles; (2) arranging a method for allocation of material to orders in process or contemplated; (3) creation of stores accounts, which will, on these bases, control the storeroom and not be controlled by it.

Setting maximums and minimums on materials. To set maximums and minimums will be advisable, regardless of the number of articles of stores or worked materials to be controlled. If there are large numbers of articles it will be well to divide them into broad classes, the individual articles in which will all have maximum and minimum quantities controlled by the same factors. The factors which determine the maximum and minimum point for each article of stores may be divided into two broad groups. First is a group of general factors applying to all articles carried, such as general business conditions and the prospects of the particular business. Second is a group of factors directly dependent on the article itself. These are somewhat intertwined with the first group, but may

cause special treatment for some particular material. There has never been developed a satisfactory formula for fixing maximums and minimums. Each article or class of article must be considered in its relationship to the factors mentioned.

Predicted consumption during a given period, as indicated by general market conditions, by the state of health of the concern, and by the announced firm policy toward lines being manufactured, forms a basic consideration which is reflected in all other factors. In periods of increasing production and great market demand, ordering quantities may be raised, and minimums must frequently be raised. This is not only because of the more rapid consumption of the articles, but because general business conditions have brought with them conditions in the market and transportation conditions which make it impossible to replenish supplies of materials as rapidly as is usual. Under reverse conditions, the minimums must be lowered generally. A major factor to be considered at the same time is the probable trend of prices in the commodities to be purchased. This may or may not follow general market conditions. Two more general factors peculiar to the business are the condition of finances and available capital in the business itself, and the extent of storage facilities which are available. In considering this latter factor, the cost of new storage facilities, or interest thereon, must be balanced against the cost of carrying inventories which the present storage facilities can handle. Changes in the line of product, particularly standardization programmes in process of development, may easily be the most important of these factors which are general to all materials carried.

There are a number of factors which are peculiar to each article and which must therefore be considered separately for each. First, there is the consumption of that article over a past period. This must be considered in connection with the general factors just mentioned. Then there is the profitable manufacturing or ordering quantity. The latter, particularly on special goods, implies the profitable manufacturing quantity in the vendors' plants. These can best be determined by experience and quotations. Ordering quantities must always be set with due regard to commercial usages. It is valueless to set an ordering quantity which is mathematically correct, but which does not represent a quantity which can readily be ordered on the market, or profitably manufactured within the plant itself. In determining the importance of this last factor, the desirability of keeping certain men or departments busy at a given time must necessarily influence. Thus some concerns, with capital available, have actually raised their minimums in times of poor business, in order to keep their working force employed.

Other factors to be considered separately for each article are: (1) its probable depreciation or obsolescence; (2) on small, inexpensive items, the

clerical cost of ordering, receiving, and paying (this may readily cause the ordering quantity for inexpensive items to be raised); and (3) the time necessary to secure the article after requisitioning. On purchased goods for which there is a regular source of supply this will include the delivery promises of the vendor and the time taken to transport the article to the user's plant. On worked materials, it will be dependent on the time taken to work up a manufacturing order for the ordering quantity within the plant itself.

The first step in inventory control has been taken when the maximums and minimums have been set. On standard products, made to a manufacturing schedule, these may often be set in a much simpler way by setting production requirements for a given time as the minimum, and production requirements for another stipulated time as the ordering quantity. The other steps in inventory control may be taken through the utilization of a balance of stores sheet such as that in the attached illustration, which is a stores record with a vision. Such a balance of stores sheet actually controls stores, rather than being controlled by them. Furthermore, it provides the necessary method for allocating material to orders in process or contemplated.

The balance of stores sheet. Many forms of balance of stores sheets have been devised to meet individual operating conditions, but all which give the necessary control are uniform in providing four important balance columns, which actually, together with the maximums and minimums which have been set, control the inventories. These balance columns (Fig. 70) are headed "Ordered," "On Hand," "Applied on Orders," and "Available." Applied on Orders is sometimes expressed as "Apportioned." In either case it governs that material which has been allocated to given manufacturing orders, but not yet withdrawn from the storeroom.

The Applied on Orders column insures that material will be on hand when wanted for manufacture, and successfully eliminates the practice of relying on the same lot of material to fill two orders. Unless materials are applied as delivery dates are stated and schedules for manufacture are prepared, it will become likely that the planning department will rely twice upon the same materials. The Available column indicates the amount of material which is still available for assigning to orders. The last balance in this column is continuously compared with the stated minimum to determine when to order, rather than the balance in the On Hand column. Unless this were the case, goods might be on hand well above the minimum, but might be ordered into production to-morrow for orders already in the plant, to such an extent that the danger point might be reached and passed long before a new supply of goods could be secured. This balance sheet provides a continuous check as to its accuracy, inasmuch as Column 1

(Balance Ordered) plus Column 4 (Balance on Hand) should always equal Column 5 (Balance Applied on Orders) plus Column 6 (Balance Available) after any transaction has been entered.

BALANCE OF STORES SHEET

NAME OF ITEM 3" Cold Rolled Steel — LOCATION X47 — MINIMUM STOCK 1000 ft. — MAXIMUM QUANTITY TO ORDER 4000 ft. — CLASS SV35/R — LOT OR PAT. No.

SPECIFICATIONS

1 ORDERED DATE	1 ORDERED QUANTITY	1 ORDERED PURCH. NOTICE SHIPM. No.	1 ORDERED ORDER NO.	2 RECEIVED DATE	2 RECEIVED QUANTITY	2 RECEIVED PRICE	3 ISSUED DATE	3 ISSUED QUANTITY	3 ISSUED FOR ORDER NO.	4 BALANCE ON HAND DATE	4 BALANCE ON HAND QUANTITY	4 BALANCE ON HAND PRICE	5 APPLIED ON ORDERS DATE	5 APPLIED ON ORDERS QUANTITY	5 APPLIED ON ORDERS ORDER NO	6 AVAILABLE DATE	6 AVAILABLE QUANTITY	MEMO.
										12/14	1500						1500	
							1/6	400	1816		1100						1100	
							1/20	200	1830		900						900	
1/21	4000	764	4400										1/21	1500	1848		4900	
							1/23										3400	
							1/24	600	1848		300			900	1848			
				1/5	4000						4300							
							1/27	300	1848		4000			600	1848			
													1/30	3600	1882		400	
1/31	4500	890	4500														4900	
	2000			2/3	2500						6500							
							2/15	800	1882		5700			2800	1882			

MEMO.

Fig. 70.—Balance of Stores Sheet.

To clearly indicate the operation of this sheet, the accompanying illustration will be explained. The article, Three-inch Cold Rolled Steel, has had its minimum set at 1000 feet and its maximum at 5000 feet, thus

giving a normal ordering quantity of 4000 feet. On December 14, 1922, when this sheet was opened, there was on hand a balance of 1500 feet, which amount was also available to be assigned or applied to orders. The first transaction was an issue to the shop of 400 feet, without previous application to any order. The next transaction was a similar issue of 200 feet, which brought the balance available below the minimum, and hence caused the ordering of the normal ordering quantity, 4000 feet. Upon ordering, this amount is considered immediately available for application upon orders, although it is naturally not ready for issue. On December 27, production order No. 1848 was entered, and this called for 1500 feet of this article, which was immediately assigned to this order and taken from the available column. On January 4, 600 of this amount was issued to the shop for production and therefore deducted both from the balance on hand and the balance assigned to orders. Next, the material on order arrived, and was properly deducted from the balance ordered (by drawing line across the column) and added to the balance on hand. The next transaction called for the issuance of 300 more feet of the material apportioned to production order No. 1848, which was therefore deducted from the balance on hand and the balance assigned to orders. On January 30, production order No. 1882 was received, which made necessary the apportionment of 3000 feet of the material. This was added to the balance applied on orders, and deducted from the balance available. This transaction once more brought the balance available below the minimum, and to bring this as close to the maximum as feasible, 4500 feet was immediately placed on order, this being a commercial ordering quantity of this article. On February 13, 2500 feet of this latest amount ordered was received and deducted from the balance ordered and added to the balance on hand. On February 15, 800 of the quantity applied on order No. 1882 was issued, and thus deducted from the amount on hand and the balance applied on orders. This series of transactions illustrates the more important types of transactions carried on upon this sheet, and shows how the sheet makes possible intelligent control of inventories, so as to allow in advance for all production needs, without unnecessarily tying up capital in material on hand.

In Fig. 70 there are but two transaction columns (number 2 and number 3). Frequently there are transaction columns provided for each of the balance columns, as indicated by Fig. 71. This sheet completely separates transactions and balances and is particularly valuable when used for machine posting. It also indicates a method of splitting balance columns to give detailed information desired. There are a number of ways in which these columns may be split without in the least changing the basis of operation of the balance of stores sheet. Thus the Available column may be split into " Available for apportionment " and " Available

for issue." This would give immediately, without subtraction, the amount of stores actually on hand which might immediately be issued without interfering with apportionments already made. The Ordered column may be split into divisions such as "Ordered but not acknowledged," "Ordered and acknowledged," and "In transit." If this is done materials may not be deemed available, if it is so desired, until they are entered in one of the latter two subdivisions. The On Hand column might be split into "On Hand—Complete Lots" and "On Hand—Broken Lots." Under some conditions this aids in keeping lot costs separate. Value columns may or may not be inserted, but are usually found. Values may be kept by the average or lot basis, as is desired, but in either case lot costs are easily ascertained from the record.

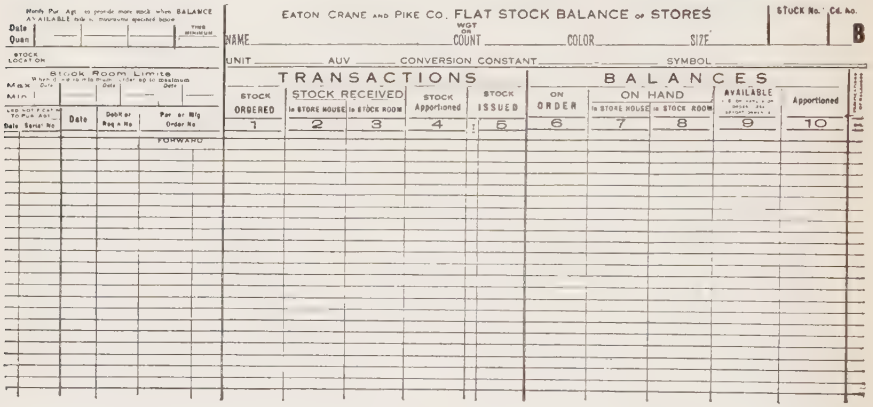


Fig. 71.

The balance of stores sheets may be operated by any division of the business which the organization may feel is best from its standpoint. They may be kept in the general accounting office, in the storeroom, or in some portion of the production office, preferably the planning department. It is usually best to separate control of stores from the stores-keeping function, and since the operation of the balance of stores sheets is primarily a function involving thinking ahead, and since it is so closely bound up with control of production, the most logical place to operate it is from the planning department.

Position of inventory control in the business. No method for the control of stores is a substitute for business judgment. In fact, judgment must be carefully exercised in carrying on the control methods just described. No methods as yet devised will automatically increase minimums on a rising market or decrease them on a falling market. They provide a

useful tool for the management and are a means to an end. Together with the balance of stores sheet, they form a very satisfactory basis for good inventory control. They must be supplemented by other management steps. These include the establishment of a proper physical basis for the inventory control that has been set up; proper storeroom operating methods, in which the development of a good paperwork system is very important; and intelligent purchasing, carried on by a purchasing agent who is able and willing to co-operate with the other branches of the business interested in inventories. These other factors which make possible a complete control over inventories will next be discussed.

CHAPTER XXXIV

THE PHYSICAL BASIS FOR INVENTORY CONTROL

Types of goods stored. Storerooms of manufacturing establishments must deal with three main types of goods: (1) Raw materials, properly termed "stores." These include supplies, or goods only used indirectly in production. (2) Partly finished materials, or stores on which some work has been performed. These are usually termed "worked materials," and may include finished components awaiting assembly or shipment to customers as replacements. (3) Finished product awaiting shipment, properly termed "stock." Storeroom arrangement and operation must take into account the varying problems presented by these separate classes of goods.

Location of the storeroom. In considering plant layout it was shown that the storeroom should be centrally located with respect to the production floors on which the material is used. This idea of a central location has been over-emphasized in some plants. They have felt that centralization means that there can be but one storeroom, and they have defeated the very purpose at which they have aimed, namely, decreasing the expense incident to handling and rehandling material. The storeroom may consist of one room, one building, or a main storeroom with subsidiary storerooms advantageously located for the storage of special materials or materials for particular departments. The nature of the industry, the site occupied, the situation and size of the buildings, and the arrangement of departments within the building must determine storeroom location. For instance, with bulk materials, ease of receiving through the use of gravity may place the storeroom far from the point of use of the material, which may be reached through the use of overhead cranes or conveyors at a smaller cost for small lots of materials than for the large lots in which the materials are received. To place such material near the point of usage would only mean two handlings of the material by the conveyors or cranes instead of one, and would increase rather than reduce the handling charges.

The location of the storage space will depend on the nature and value of the materials to be stored and the rapidity with which amounts will be received and issued, as well as upon the point at which they will be placed in manufacture. Bulky materials, such as sand or pig-iron, demand

different treatment from that given to material which must be handled. Material such as paper pulp is too bulky and used too rapidly to be stowed into bins. However, the storage problems relating to such materials can well be studied. For instance, paper pulp instead of being stored in huge piles, involving rehandling when needed, can be placed on platforms to be picked up by transfer trucks, each platform containing a standard quantity properly tagged to indicate lot numbers and specifications.

Heavy materials generally must be stored on the ground floor, whereas material that is light can be easily handled and can be fitted into almost any location that is otherwise desirable. Materials which are easily broken require facilities for protection and this protection must take precedence in the fixing of the storage place. Similarly, valuable material necessitates not only consideration of location but of safety. Some articles can be stored only under particular temperature conditions, and the storage place must be fixed with temperature regulation in mind. For instance, rubber must be stored in a place that is neither too dry, too damp, too cold, nor too hot. Inflammable material often demands a separate storage space that will not only protect the material itself, but will also reduce the fire hazard for the remainder of the establishment. This may mean that a separate building may have to be erected, or a sort of fireproof vault provided within the storeroom, possibly communicating with the remainder of the storeroom through double fire-doors.

Despite these special considerations, most goods can be stored under the same general conditions. The recent developments in trucking and conveying equipment have tended to make various parts of a plant closer to one another from the trucking standpoint and thus have increased the possibility of the centralization of the storeroom. It is no longer necessary to have the storeroom immediately adjacent to the department using the goods in order to secure quick deliveries.

Any plant for the location of a storeroom must be flexible enough to allow for growth and other changed conditions which arise over a period of years. If such conditions cannot be foreseen, or if the material stored will only be used for a short period, it may be profitable to consider the construction of temporary storage conditions that can be changed readily. Temporary platforms in a factory yard, with tarpaulin covers, have solved more than one such temporary storage problem. Relative cost must be the paramount consideration.

Storeroom layout. Having determined upon the general location of the storeroom with respect to the other departments of the establishment, the next step is to work out the layout and arrangement of the storeroom itself. The area to be provided for storage purposes will have been worked out during the study of the location of the storeroom. Too much space will add to the indirect cost of storing the material. On the other

hand, insufficient area will increase costs because of the congestion that will result. Lack of space granted the storeroom will often lead to a reduction of the quantities that may be carried, so that production is seriously hampered. The problem of the amount of storage space to provide is easily solved where a standard product is being manufactured, but it causes considerable trouble where numerous products of varying kinds are being produced. Where, because of the peculiar nature of the business, it is difficult to determine the exact amount of space needed, the better policy will be to allow for extra space rather than too little. In the long run, the cost of this policy will be less.

The physical arrangement and layout of the storeroom involves allotting space for more than the actual storage of the goods. For smooth storeroom operation it is necessary that a section adjoining the entrance to the storeroom be reserved for the receipt of material as well as for its inspection prior to storage. Also, space must be provided for material withdrawn for issue to the production floors, but not yet removed from the storeroom. This will enable the man in charge of the storeroom to work up his issuances in advance, in order that there will be no delay when the goods are actually required. The confusion avoided in handling receipts and issuances will more than justify such an assignment of space. While considering the arrangement of the storeroom it must again be noted that the stores manager will usually be called upon to store certain bulk materials in the factory yard. These materials command just as careful consideration for economical handling as any other articles.

As in the case of the layout of the production floors, one of the most essential features of storeroom layout is the provision of adequate aisles and passageways. These should be sufficiently wide to allow the bringing in and taking out of supplies in the most expeditious manner. Aisle space should be reserved for use as aisles only, since nowhere more than in the storeroom does material stored in aisles cause delay in handling goods. In the case of bulk storage, the storage areas and aisle spaces may be marked on the floor with paint. The layout of aisles will vary according to the needs of each storeroom, but in general it may be said that main aisles should allow the passage of two trucks and should vary from 6 to 8 or more feet in width, while other aisles will usually only have to allow for one truck. In blind aisles running up to a wall, allowance may have to be made for the turning of the truck. Where the articles stored are of such a nature that they are generally carried by storesmen, the width of the aisles between the rack has been standardized at 30 inches in some storerooms. Wherever possible, aisles should be directly opposite windows for adequate light and ventilation, since there is no economy in narrow, dark aisles. Congestion and mistakes soon occur, and workmen move by hand what should be handled by trucks. Errors in stowing and removing

goods are frequent. Figure 72 indicates the proper relationship of aisles to storeroom layout. The desirability of a central location for receiving and issuing, as well as assembling stores for stowing or issuing, is also shown.

Arrangement of material in the storeroom. The arrangement of the material within the storeroom will depend largely on the articles to be handled, the use to which they are put and the classification which has been developed. One of the chief advantages of a well-developed classification is the aid that it gives in storeroom operation. Before the storeroom can be arranged, it is first essential that there be established a systematic arrangement and designation of the material to be handled. These we have seen are best secured through classification and standard nomenclature. Regardless of whether the storeroom is arranged by classification

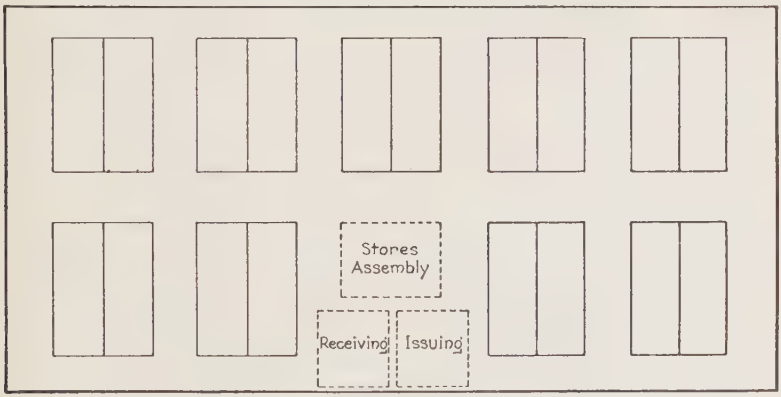


FIG. 72.—An Effective Storeroom Layout.

or not, this will prove to be of value in arrangement. There are two main ways of arranging a storeroom: (1) directly by classification; (2) by index. Both are widely used.

If material is arranged by classification, it should be stored in the classification order. If the mnemonic system is being used, the first racks should include all those articles whose symbols begin with F, or whatever is the first letter, and the last racks should have stored on them those articles whose symbols begin with W, or whatever the last letter may be. All intermediate racks should be alphabetically arranged, and a system should be developed for the alphabetical arrangement of each of the racks themselves, so that an article of stores may be found in the rack much as a word may be found on the page of a dictionary.

This arrangement of materials may be best illustrated by indicating the way in which it might be worked out in a particular plant. At the end of each rack on a central aisle, keyboards are placed which indicate the range of the contents of the rack. For instance, one of these keyboards might

read SVZM-SVZY. This would immediately indicate that all articles of stores whose symbols were alphabetically between these two could be found in this rack, and this fact would be used in much the same way

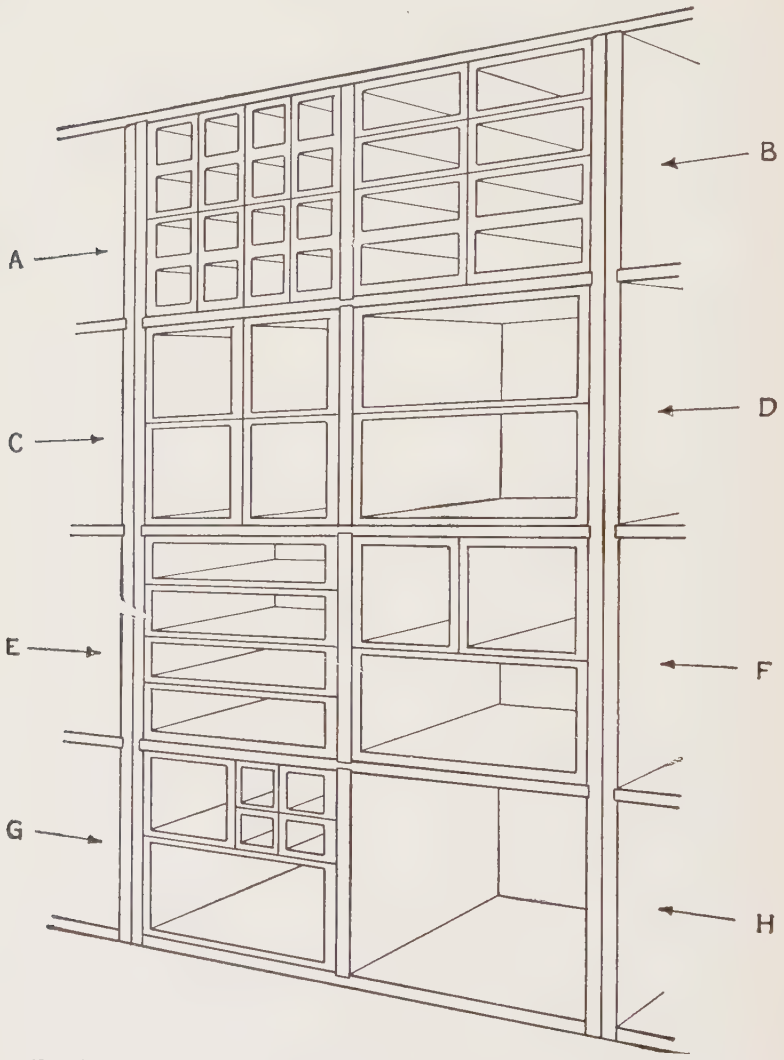


Fig. 73.—Storeroom Bin Arrangement. Flexibility in use of wooden bins.

that the tabs on the side of a dictionary are used in finding the approximate location of a word. Each rack is divided into divisions, and these into sections and subsections, as is indicated in Fig. 73, which is an illustration of a main division. In stowing and locating material, each division is

read separately, beginning with the upper left-hand corner (Section A), then across to Section B, down to Section C, and so on until Section H is reached. The subsections in each section are read in the same manner, the top row being read clear across before the next row below. Thus, in arranging stores by classification, the symbol of the article in the upper left-hand subsection of Section B would immediately follow the symbol of the article in the lower right-hand subsection of Section A. This whole arrangement makes easy the finding of an article without walking up and down in front of the rack.

Consider an issue for 50 of an article symbolized as SV $\frac{3}{8}\times1\frac{1}{4}$ Z2M. Since the keyboards on the ends of the racks show the range of the articles stored in the racks by letters only, the figures may be disregarded for the time being, and SVZM will be looked for. This we will quickly find to be in the rack above mentioned, namely, SVZM-SVZY. We then proceed to look through this rack for SVZ2M, which we would immediately see was in a division near the beginning of the rack because the symbol is a subdivision of the first symbol on the keyboard of the rack. Having found this division of the rack, it is but the matter of a moment to locate the particular section and size of screws desired in this instance, namely, $\frac{3}{8}\times1\frac{1}{4}$.

It is almost impossible for one unfamiliar with this arrangement to realize the ease and speed with which material can be located under this system. It is particularly valuable with small parts and for the storage of forms and office supplies. Storekeepers whose materials are thus arranged delight in taking the visitor to the storeroom, explaining the system to him, giving him a symbol to find, and watching him pick out the section of the rack in which the material is stored within a few seconds. A storeroom having its material so arranged is not dependent on one man recalling where he has placed certain material. The plant would not be greatly handicapped even if the whole storeroom force were to leave suddenly. However, arrangement by classification can be utilized only where there is no rapid change in goods handled. Under other conditions it is not advantageous, because it causes continual rearrangement of the storeroom. Under any circumstances it has certain very definite disadvantages: (1) A large amount of space (20 to 25 per cent) must be left in each portion of the rack to allow for expansion. (2) The goods most frequently issued cannot be placed near the issue window without breaking down the scheme of arrangement. (3) Certain goods, such as unwieldy materials or very heavy articles, can under no circumstances be stored exactly by symbol.

The second successful method of arranging a storeroom is by index. The materials in the storeroom are arranged in the manner most convenient for storage and issue, and then an index of material location is developed. In the index the material will be arranged by symbol, and

the location in the storeroom noted next to the symbol. This method necessitates designating the racks, rows, and sections in some manner that will allow the bin location to be expressed in the form of a symbol also. One method of symbolizing bin locations is illustrated in Fig. 74. The racks are lettered, and the rows in the rack are numbered, beginning from the bottom. Finally, each row in the rack is marked off into numerical divisions, which may or may not correspond with the bin arrangement. In designating bin locations, the row is used as the first digit, and the division number the last two. Thus, if the index indicated that an

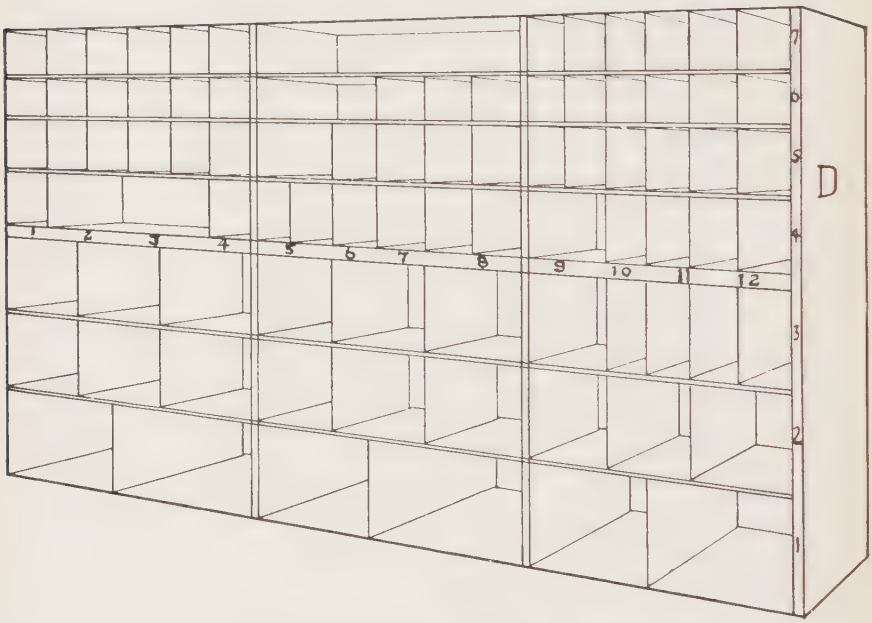


Fig. 74.—Storeroom Bin Arrangement. Steel bins—by index.

article could be found at D 408, this would indicate the article was in rack D, row 4, position 8. No attempt is usually made to number bins under this plan. It is particularly satisfactory if steel bins are used.

For the storage of large articles, which cannot be placed in bins, the storage floors may have each bay and section lettered or numbered, in such a way that the location of articles may be recorded in much the same fashion as if they were stored in bins. Such symbols are frequently painted on supporting columns or suspended from the ceiling.

The chief disadvantage of arranging a storeroom by index rather than by classification is that the index must be consulted before an article can be found. If the stores are well controlled this is not important, for the bin location can be inserted on the stores issue at the time that it is written.

The advantages claimed for the arrangement by index are: (1) Stores can be so arranged that those which move fastest are nearest the points of receipt and issuance. (2) No rearrangement of the storeroom is necessary as new articles to be stored are brought in or storage of certain old articles is discontinued. (3) Goods can be stored with full regard for their special requirements for storage.

Types of bins. Wherever possible, and always where large numbers of small articles are handled, racks containing bins should be placed back to back, making material accessible from aisles running between the rows and thereby economizing storage space.

Obviously, the character of the stores will determine the size and method of subdivision of the bins, but some such plan as illustrated by Fig. 73 or Fig. 74 should be adopted. Figure 73 illustrates the use of standard wooden sections. These racks are made of 2-inch lumber, each division having eight sections, the inside dimensions of which are 2 feet in height, 2 feet in width and 18 inches in depth. For purposes of flexibility some such unit should be devised, to fit the particular conditions encountered. In this illustration, each 2-foot division can be used as a whole for the storage of materials, or it may be subdivided by inserting units or smaller bins. Thus one compartment is filled with sixteen boxes or bins known as sixteenths. The construction of these boxes is such that their outside measurements are equal, making possible the placing of sixteen of them in a division. The sixteenths would, therefore, be approximately 6 inches square outside. Eighths, quarters, and halves are also used. The flexibility gained through this method of bin arrangement may be readily contrasted with the more usual method of having all bins of equal size by reference to Fig. 75. The amount of waste space in this illustration is obviously expensive. Figure 76 is an illustration of a well-laid-out storeroom utilizing steel bins. Although such bins are of varying size, they are rarely changed, after being set up, except by inserting or removing dividing partitions. The rows are composed of standard steel shelving.

Both the wooden bins and the steel bins which have been illustrated make for very satisfactory storage arrangements. When standard lots of small materials are frequently issued the idea of using tote-boxes as bin compartments should be considered. Steel shelving occupies less space than does wooden shelving, but it is more expensive. About 80 per cent of the space occupied by steel bins can usually actually be used for storage, whereas only about 50 per cent of the space occupied by the wooden bins described can be so used. Despite this fact, the cost of the steel bins per cubic foot of storage space will ordinarily be almost twice that of wooden bins. The better appearance and the sanitary and fireproof features of steel bins often cause their adoption.

Many materials cannot be stored in the type of bins illustrated, and

special provision must be made for their storage. Such materials are bar stock and automobile drive shafts. Bar stock is ordinarily stored by placing it horizontally on the sides of racks shaped like an A, having hooks on the sides to hold the stock, or by leaning the stock vertically against such A racks. Automobile drive shafts are ordinarily suspended on special racks to prevent bending. Many fragile articles, such as lamp shades, are suspended from the ceiling, thereby minimizing the jar to which they are subjected, particularly in buildings where heavy machinery

FIG. 75.—Waste of Space through Inflexble Bin Arrangement.

is operating. Special storage also includes storing articles in the original package. Where there is a heavy turnover of small articles and the container is such that it fits in with the general storeroom scheme, this is sometimes very advisable. On the other hand, this practice must be carefully controlled, since it is usually cheaper to break original packages when they are received than when the storeroom men are in a hurry to make issues.

Many storerooms use the double-bin system, providing two bins for each type of material. It is evident that the double-bin system generally requires more space, but those who use it feel that this additional space is

not a serious enough factor to over-balance the advantages in its favor. The double-bin system provides an "in" and an "out" bin for each article. While the material in the "out" bin is being drawn for use in the factory, newly received goods are being placed in the "in" bin. When the "out" bin is empty, withdrawals are begun from the other bin which is now tagged "out," and the empty bin becomes the receiving bin. The double-bin system prevents the accumulation of old material in the bottom of the bin, since it is used up before the new material is issued. This is of special benefit in the case of material which is likely to deteri-

Courtesy David Luptons' Sons Co.

FIG. 76.—A Storeroom Utilizing Steel Bins.

orate. Another advantage of the system is that it gives a continuous physical check on the material to compare with the records, and this check can be made and is made each time that one of the bins becomes empty. This system is only successful when the kinds of materials carried in stock are more or less constant. When the amount of material of a given kind changes considerably, or the material is only carried intermittently, the single-bin system is generally better because of the saving of floor space. The single-bin system is far more extensively used.

Auxiliary storeroom equipment. No discussion of the physical aspects of the storeroom would be complete without some further reference to storeroom equipment, particularly to conveying equipment, which has

been so extensively developed within recent years. If material is to be moved quickly and inexpensively a small investment in this type of equipment is practically necessary. Elevating transfer trucks, which pick up platforms on which material has previously been piled, are particularly well adapted to storeroom work. Two-wheel trucks with special holding devices or arms to prevent the slipping of the load are invaluable for the conveying of barrel lots of materials, such as oils. The development of the tiering machine (Fig. 77) has increased the possibilities of space-utilization in every bulk-goods storeroom with a high ceiling. In one large storeroom the storage of barrels containing heavy material had always been done by hand. The practice had always been to store such barrels three high, which required five men to handle the barrels. With the purchase of a tiering device two men were able to do the same work, and instead of piling the barrels three high they are now able to pile them five high.

Small platforms may be used, on which quite a number of boxes or cans can be placed. These platforms may be home-made to fit peculiar conditions. In one storeroom these platforms are made of lumber 1 inch thick, and the platform is 7 inches high, 30 inches wide, and 44 inches long, leaving an opening under the platform about 20 inches wide and 6 inches high into which the elevating truck is pushed. The truck has a capacity of a ton and is easily handled by one person.

One of the perplexing storeroom problems where bins are used, and one that frequently prevents the use of the full height of the storeroom, is the problem of reaching the upper tiers of bins. The general practice is to use steps or ladders, but these are continually getting in the way, blocking aisles, and, in the case of ladders, causing accidents, because the worker tends to lean too far to one side rather than move the ladder. One stores manager has developed the practice of arranging the bins in such a manner that the compartments at the bottom are large enough to receive heavy or bulky material, while those higher up decrease in size as they increase in height. For instance, at the top of the first row, the depth is reduced by one board, or a foot. This forms an offset that is usuable as a platform in reaching the bins above the second tier. From this the workmen have easy access to material 5 or 6 feet above, thus making it possible to reach goods to a height of 8 to 9 feet without the use of a ladder or steps. However, ladders may be necessary under certain conditions, and where such is the case, those on trolleys have usually been found to be the most satisfactory. Some storekeepers object to the step arrangement of the bins because they feel it invites storeroom workers to lay articles on them "temporarily."

It is obvious that the kinds of apparatus used for conveying materials from the storeroom to the shop will depend largely on the material involved, the layout of the storeroom, and the size of the plant. Thus in large

establishments, railroads, motor trucks, and cranes may be found effective as links in the stores system. The automobile industry has been quick

Courtesy Revolvator Company.

FIG. 77.—A Tiering Machine.

to realize the advantages of power trucks despatched on schedule. Emergency requirements are easily met, since deliveries are systematically made. In automobile plants it is a common sight to see the overhead carrying

equipment supplemented by small lorries driven by electricity or gasoline, continually moving through the plant carrying material from the storerooms. Overhead carrying systems, generally electrically operated, are also one of the more recent conveying developments which are particularly applicable to the problems of large plants.

Storeroom personnel. To maintain any effective system of storeroom operation, the personel of the storeroom must be well organized. It is essential that it should be in charge of some person who is directly responsible for the conduct of all its affairs. Fixed responsibility is especially necessary in the storeroom. Regulations must be put into force which prohibit all but storeroom employees from entering this department or which permit them to enter only in the presence of the storekeeper or one of his assistants. Only under such conditions will it be possible to make the storekeeper solely responsible for the preservation of and correct accounting for material. The size and character of the organization for the storeroom will vary with the size and the character of the business and the character of the material to be handled. Thus it may consist of one man known as the " storekeeper," who may give all or only part of his time to the work, or it may consist of a force of men giving full time.

The statement may be heard that such conditions are only applicable to large plants. On first thought it may appear to be poor practice for the small concern which can only keep a man partly busy on storeroom work to place one man in charge of the storeroom. Even for the small plant, however, it is advisable. For instance, it may be quite possible to assign an office employee to the storeroom for a certain length of time each day. By establishing certain hours in the morning and the afternoon this clerk can take care of all calls for material. At other hours he can attend to his regular work in the office. Some companies have met the situation by placing a workbench in the storeroom at which a worker is engaged while not devoting his time to storeroom work. A manufacturer of centrifugal machines employing fifty men has combined the functions of storekeeper and shipping clerk in one man. As a result, responsibility for the storeroom is focused on one man and a full day's work is being obtained from him.

CHAPTER XXXV

STOREROOM OPERATION

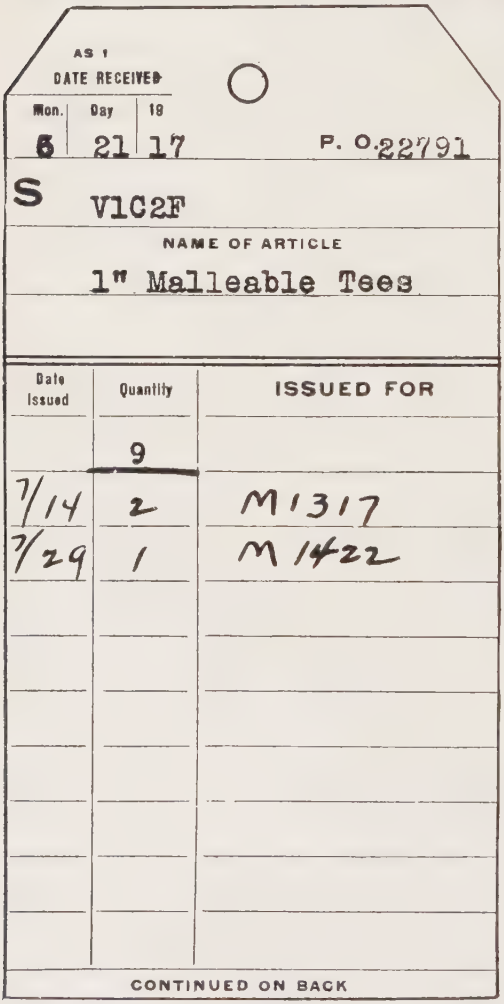
With the creation of balance of stores control, if this function be carried on elsewhere than in the storeroom, there should be a minimum of stores records maintained in the storeroom itself. The storekeeper can nevertheless be of great aid in carrying a share of the load of controlling inventories, if he studies conditions within the storeroom and the shops, ascertains needs and co-operates with the purchasing department and the balance of stores clerk. In insuring smooth and prompt operation of storeroom routine will lie his greatest service toward good inventory control.

The storekeeper can provide a positive check that will insure that articles on hand will not fall below the designated minimum. This can be provided in some cases through the physical separation of the minimum by a partition, by placing it in a separate box, or by tying it together in a way which will call attention to the fact that some of it is being issued. Another check can be provided in the form of a bin tag on which records of receipts and issues can be maintained. If a separate bin tag be utilized for each lot received and issues deducted from the tags, sending bin tags which read zero to the balance of stores clerk may prove a valuable check. Figure 78 illustrates a very satisfactory form of bin tag. To be effective it must be simple, because of the usual character of storeroom labor. Many managers feel that a bin tag is unnecessary and that it serves no valuable purpose, particularly since it is difficult to keep it accurately.

Procedure for ordering material. The procedure for receiving goods into the factory storeroom will be described in detail. Goods are ordered by the purchasing department, either upon their own initiative or, in procedures such as we have described, on requisition of the balance of stores clerk. For special materials, unclassified, requisition will usually be made direct by a department head, although approval by the balance of stores clerk may be made necessary to prevent duplication of items. After receiving the requisition, the purchasing agent makes the purchase, and then sends a copy of the purchase order to the balance of stores clerk, which is the basis for an entry in the "ordered" column of the balance of stores sheet. A copy of the purchase order may be sent to the storekeeper to serve as a basis for identifying and checking material when

received. Some plants do not enter the amount ordered on the copy which goes to the storekeeper, in order that accurate count on incoming goods may be assured.

Receiving stores. All material received should be turned over to the receiving department, which may or may not be under the control of the storekeeper. If articles were delivered directly to the person for whom they were ordered, in many instances the receipt would not be recorded, which would lead to difficulty when the invoice was received. The date received, order number, weight, number of packages or bundles, charges whether prepaid or collect, and other necessary information should be recorded, so that a check can readily be made with the invoice.


AS 1
DATE RECEIVED
Mon. 6 Day 21 18 17
P. O. 22791
S V1C2F
NAME OF ARTICLE
1" Malleable Tees

Date Issued	Quantity	ISSUED FOR
	9	
7/14	2	M1317
7/29	1	M1422

CONTINUED ON BACK

Fig. 78.—Bin Tag.

As soon as a shipment is received the storekeeper should refer to his copy of the purchase order. He should be responsible for the count and ordering of inspection of all materials received. Theoretically, this should take place before the goods are accepted and receipted for. However, to facilitate receipts by team or truck, delivery receipts are often signed as follows: "Received subject to count, weight, and inspection. Signed——." In this event the contents are carefully checked and inspected at a convenient time. As soon as the material has been physically checked by the receiving department, a comparison should be made with the copy of the purchase order. Word should be sent to the purchasing department,

stating the quantity of material and the general condition in which it was received. Such a report is usually termed a " Notice of Arrival," one copy of which goes to the inspection department as a notice that inspection is needed.

Upon inspection, the inspector should fill out an inspection report, stating that all material is satisfactory or indicating rejections, with causes. One copy of this report should go to the accounting and one to the purchasing department to serve as a guide for the checking and payment of the invoice from the vendor, and for the making of claims. Where it is obvious that the material has been damaged or partly lost in transit, notice should be sent to the agent of the carrier to inspect the material. This will facilitate matters where a claim is to be formally made. Receipts of material in excess of the amounts called for on the purchase order should be tagged as " over shipment," with proper identifications, and placed to one side awaiting final disposition. A rejection tag should be placed on damaged or incorrect shipments. It is essential that descriptive data such as purchase order number, incorrect report number, kind of material, and similar information be stated on it. The procedure incident to inspection must vary greatly from plant to plant and industry to industry, depending on the plant organization and the nature of the material.

When the inspection report has been received, the storeroom should make out a " Material Received " report. It should preferably be made out in four copies and signed by the storekeeper. One copy should go to the balance of stores clerk who will check against the purchase order and make proper entries on the balance of stores sheet. One copy should be retained by the storeroom while copies should be sent to the purchasing department and accounting department to serve for checking invoices.

Handling materials returned from the shop. Materials returned from the shop comprise two classes, those which are returned because of necessary over-issue in the first instance and those which are returned because some change in the schedule or other complication makes desirable the prior processing of other orders than those for which the particular material was issued. With proper methods of issuing, usually only the exact quantities of material needed will leave the storeroom, but it is possible at times that over-issues must be made. For example, if bar stock is to be issued, it may be that the length called for on an issue slip is slightly less than the shortest piece in the storeroom. In that event, over-length must be issued. Small ends would be scrapped under such circumstances, but worthwhile amounts would be returned to the storeroom after the amount needed had been used. The simplest method of handling such over-issues is to have the storekeeper attach a tag marked " surplus " to the article, and retain a copy. If the surplus amount is returned he destroys all records,

but if the surplus amount is not returned from the shop, he makes out an issue slip and sends it to the balance of stores clerk to be properly deducted from the amount on hand and be charged to the proper accounts.

If materials are not immediately needed as had been expected they should be returned to the storeroom and not kept on the production floors. When materials are so returned the storekeeper makes out a "Stores Credit" (Fig. 79) and sends this to the balance of stores clerk. This slip serves to credit the order to which the materials have previously been charged, and goes to the cost-accounting section for that purpose, after the proper entries have been made on the balance sheets.

MONTH	DAY	YEAR
10	21	22

A8-23

STORES CREDIT

CREDIT ORDER NO. MK 422

STOREKEEPER:

PLEASE CREDIT THE FOLLOWING:

SIGNED G. V. M.

SYMBOL	QUAN.	DRAW. NO. OR DESCRIPTION	WEIGHT	UNIT COST	TOTAL COST
SS2C1F	3	11986			

ENT'D STORES TAG BY	MONTH	DAY	YEAR	STORES ABOVE HAVE BEEN RECEIVED	ENT'D INVY.	ENT'D COST
				STOREKEEPER		

FIG. 79.—Stores Credit.

Receiving worked materials. Materials on which a certain number of processes have been performed, or components awaiting assembly must be received and stored until needed. The storeroom will handle these in the same general way as material purchased from vendors, except that no inspection will be needed, and the form on which receipt will be reported will ordinarily be a "Worked Materials Received" slip, rather than a "Stores Received" slip.

Stowing. After materials for storing have been received and inspected they may best be placed on a rack or space devoted exclusively to materials awaiting storage in the proper bins or racks. There all materials may be tagged with their symbols or bin location. Some classes of materials

should also be arranged in boxes or cans in suitable units for conveyance. The articles may next be arranged on a truck, in logical fashion, in order that they may be unloaded into their respective bins with the minimum of confusion and loss of time. As the specific articles are placed in their respective bins, entries are made on the bin tag, if there be one, setting forth the date and the amount.

Issuing stores. The next function to be described is the issuance of stores to the production floors. Co-operation between the users of material in the factory, the storekeeper, and the planning department is essential in order that there may exist a definite understanding with all

MONTH	DAY	YEAR
10	21	22

AS-10

STORES ISSUE

CHARGE ORDER NO. M 1318

STOREKEEPER:
PLEASE ISSUE THE FOLLOWING

SIGNED G.V.M.

SYMBOL.	QUAN.	DRAW. No. OR DESCRIPTION	WEIGHT	UNIT COST	TOTAL COST
SV1BH	100		17.6		
SVB4V	50		4.7		

ENT'D STORES TAG BY	MONTH	DAY	YEAR	STORES ABOVE HAVE BEEN ISSUED	ENT'D INVTY.	ENT'D COST
				STOREKEEPER		

FIG. 80.—Stores Issue.

concerned. There should be a well-defined rule that no materials can be obtained from any storeroom, warehouse, or yard without the presentation of a formal requisition or issue ticket (Figs. 80 and 81) signed by an authorized person. In no other way can the disposition of materials be accurately checked. It is necessary always that the storeroom receive the issue ticket from the balance of stores clerk in sufficient time to enable it to prepare the material for issuance to the workplace in the factory in such time that no delay will be encountered between the existing job and the new one.

Both for purposes of accounting and storeroom operation simplicity there are different forms provided, as illustrated, for the issuance of stores

and of worked materials. From the physical standpoint of issuance in the storeroom there is no difference in the action taken on the two forms. Figure 82 illustrates an effective stores card to be used in connection with tabulating machines. If this system be utilized, all cards may be printed in the same manner, and their various uses be designated by varying colors.

AS 13 WORKED MATERIALS TAG NO. M 13 P 9

CHARGE TO ORDER NO. C M 1416 413 P

W

ISSUED FOR 1 M 1416 413 P

QUANTITY ISSUED	UNIT		NUMBER PIECES	2
2	1			
TOTAL WEIGHT	TOTAL VALUE		DRAWING NO.	
			MACHINE NO.	

M-2003 T M-2007

	MONTH	DAY	YEAR
ISSUE WRITTEN	6	22	1922
DELIVERED			19

WORKED MATERIALS ISSUED

STOREKEEPER

MR. G

DO NOT FILL OUT NAME FOR ORDERS ON STOREKEEPER.

PLEASE ISSUE ABOVE { TO C / TO BEARER

SIGNED BY MAN FOR WHOM W. M. ARE ISSUED

APPORTIONED	BALANCE SHEET	TAG	COST ACC'T

WORKED MATERIALS DESCRIBED ABOVE HAVE BEEN ISSUED

SIGNED BY STOREKEEPER OR HIS REPRESENTATIVE

Fig. 81.—Worked Materials Issue.

In getting out the material the stores issue man should, if possible, take enough issue tickets to make up a truck load at a time. Suitable tote-boxes may be placed on the truck to receive small materials. If the issue tickets are arranged in sequence, the issue man may move from row to row in the storeroom in as direct a line as possible. Immediately upon taking material out of a bin a deduction should be made on the bin tag, if there be one, and an identification tag, stating the material symbol order number and destination in the shop, should be fastened to the tote-box or container into which the material has been put.

As soon as the material is delivered to a department in the factory it should be checked, preferably by the foreman, or at times by the individual workmen, to see that there is no shortage. Should there be fewer articles than are specified, a shortage report should be made out. Otherwise it will be taken for granted that the issue is correct, and any other issue for the same kind of material on the same production order will be contested by the storekeeper. The cause of the discrepancy, error in stores requisition, error in issuing stores, material lost in moving, or material lost after delivery to the shop, should be noted, so that an additional stores requisition may be gotten out immediately to prevent any hold-up in production. The shortage may then be charged to the party responsible for the loss. Whatever the exact methods practiced, it cannot be too strongly empha-

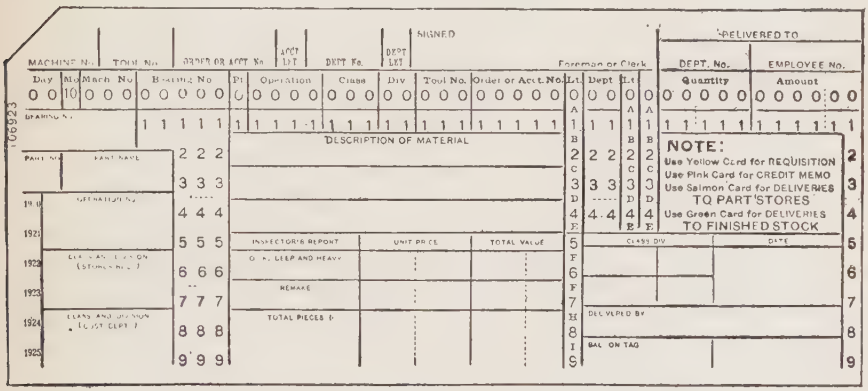


Fig. 82.—Stores Card for Use in Tabulating Machine.

sized that material should not be issued from the storeroom without a formal requisition.

The check or withdrawal slip used by depositors at banks is invaluable for accurately tracing the disposition of funds. Critics often say that such a practice in connection with the storeroom is red tape, and are eager to state that, if in order to get a screw from the storeroom, a requisition must be written out, the cost of such a procedure would be more than the value of the article to be withdrawn. It must be remembered that such a case is one fitted only for critical purposes. For practically all articles handled in the storeroom it will be well worth while to maintain a rigid control, and therefore no exception should be made for cases which will not involve more than a fraction of 1 per cent of the issuances. Office supplies and similar articles can be drawn in sufficient quantities at given intervals to overcome small issuances, a check being maintained in the office, as they are issued out to individuals.

Taking inventory. Where there is no scientific control of stores, physical inventories are the only check upon materials on hand, and hence are the only means whereby the profit or loss of the business over a given time may be determined. Although reliance on the physical inventory alone has largely passed from industry, there are still some concerns which rely entirely upon it, and more which use it to supplement perpetual inventories. Its disadvantages may be summarized as follows: (1) It is taken only once or twice a year because of the cost and inconvenience involved. (2) It is necessary to shut down the productive processes of the plant for the period during which the inventory is being taken. (3) Accuracy is usually impossible. Speed of taking is usually the paramount consideration, and no matter how highly organized the inventorying force, there are usually a number of omissions and duplications. This situation is intensified because clerks and shop workers who have no direct interest in the accuracy of the inventory and who look upon it as a mean job, must be pressed into service to help in the count.

The second, and now practically universal basic method of inventorying is through a book record or running inventory, such as the balance of stores record already described. This gives a running inventory record of every article which is kept in the storeroom. Its advantages are the following: (1) The total inventory is found simply by taking off a trial balance of the stores ledger. (2) A record of the issuances of materials is afforded, and this may be followed up to see that the materials were actually used for the purposes for which they were withdrawn from the storeroom.

Although a perpetual inventory is provided, this does not usually mean that the taking of physical inventory can completely dispensed with. Neither banks nor the Internal Revenue Bureau will accept unchecked book inventories, and from the standpoint of the business itself such practice would be unwise. A book inventory is never 100 per cent correct, and it is frequently far from this ideal, due to both clerical errors and unavoidable discrepancies between issues and issue tickets. In order to meet this situation there is provided some physical check of the book inventory. Such a check does not involve closing the plant to take inventory, but may be performed in one of the following ways.

One method is to check material as it reaches the minimum which has been set. Thus, in a hosiery mill, assuming that 5000 cones of a certain kind of mercerized yarn forms the maximum and 500 is the minimum, when the storekeeper has delivered 4500 on requisition for use in the shop, and the amount on hand has been brought to the minimum, he counts the amount actually remaining in the bin. He sends his count to the balance of stores clerk for comparison with the book record. The taking of physical inventory at the low limit requires little time and work. If there

are bin tags, it can be done by the storekeeper on his own initiative as he notices that the balance on the bin tag has reached the minimum. If there are no bin tags, the balance of stores clerk can make up for him a daily list of articles which his records indicate have reached the minimum, and this list can be made the basis for checking. Special provision may be made for checking items which have not reached their low limit during a period. Of course, in such cases, the minimum has usually been set too low and should be corrected.

Another method that may be used for checking with book records is the progressive count. In the larger companies, one or two men, or as many as may be required by the particular business, may be engaged continuously in counting materials on hand. In a smaller plant the services of a clerk in his spare time each day may suffice. In either event, at given intervals of a few months, all the material is checked. Checkers start at one part of the storeroom and make the round of the department, checking all the items in a specific number of bins each day, and comparing them with the balance shown on the bin tag and in the stores ledger.

A book record, combined with a physical check similar to the above, assures accuracy of records, and makes possible not only inventory control, but the preparation of profit and loss statements at frequent intervals, such as monthly, or even weekly. Thus the business may be operated with information concerning actual conditions constantly at hand, and if leakages are occurring these may be stopped at once, rather than at the end of six-months or yearly periods.

A well-ordered storeroom and system of storeroom operation can be put in utter confusion by two days' use of lax methods. There will frequently be the temptation to depart from the procedure which has been set up because of a rush of incoming material, or because of a sudden need for certain material in the shop. The slight time saved for the moment in deviating from the standardized procedure will be more than overcome by the complications and losses which will ensue. It should be one of the primary objects of the storekeeper to see that he and his assistants, if he have any, rigidly adhere to the procedure that has been established. If he does this, and if he keeps the storeroom always in good order and condition, the inventory control which has been established will have an opportunity actually to function.

CHAPTER XXXVI

PURCHASING DEPARTMENT OPERATION

Intelligent purchasing department operation brings with it reduction of inventories, regardless of the position of the purchasing department in the organization, and regardless of the extent of its authority. To know markets and to know how and from whom to buy are primary functions of a purchasing department that it can always intelligently exercise. Its position and authority within an organization are varied, as was brought out when discussing "Organization To-day."[1] Upon the extent of its authority rests the extent of its control over inventories. It will, therefore, be well to review and to amplify what has been said with regard to the causes which bring changes in the position and scope of authority of purchasing departments from one organization to another.

Position of purchasing department in the organization. It sometimes happens that the purchasing end of a business is directly subsidiary to the selling end, or at least they go hand in hand. Such a case always exists in a manufacturing concern where there is a quick turnover of all raw material that is purchased, with only a slight additional process having been performed. This frequently occurs in markets which are highly organized, such as the cotton or flour markets. In these cases and others, where "hedging" is carried on to protect from loss, it is practically essential that the sales and purchasing ends of the business be under the same direct control. Of course this does not apply to the purchasing of supplies. An example of such a condition is to be found in the business of mercerizing cotton yarns, where the yarns are frequently bought and sold within a few minutes' time, and the mercerizing operation, which is all that is performed by the plant, is comparatively short.

There are many other types of businesses in which the manufacturing operations are more involved and relatively more important, but in which the position of the purchasing department must be one of maximum importance. Such businesses include most of the needle trades which purchase expensive fabrics, such as men's clothing. In such an industry, a very large share of the profit made during the course of the year is made from purchases at the right time or of exactly the right materials. Thus

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the cost of the material purchased is an important consideration in the authority granted the department.

The importance of the purchasing department in factories manufacturing complicated products may depend on the degree of standardization. If the product be standard, the scope of the purchasing agent's authority usually has been so limited by those who drew up the specifications that his task is fairly simple, and, therefore, one that is subject to general manufacturing control. If the product be not standard, the purchasing agent usually must decide many matters concerning the purchase of material which would not come within his jurisdiction with standard product. Hence, his position within the organization will be correspondingly increased in authority and importance.

Curiously, there sometimes develop, for very different reasons, violent objections on the part of general executives to clothing the purchasing agent with much authority. There are three such reasons which are worthy of mention. In the first place, there is the major executive who feels that there is "nothing to purchasing." He feels that his trouble has always been to sell his product, that other men are just as anxious to sell their products as he is to sell his, and that, therefore, the task of purchasing is comparatively simple. As selling has come to be more and more a scientifically studied vocation, the purchasing department has provided the answer to this idea by employing in self-defense means as scientific as the salesman.

Many major executives enjoy doing all important buying. Spending their money they find lots of fun, and they do not want a purchasing agent to do it for them. Besides, purchasing brings them into contact with other men in their industry in a way that almost no other phase of the business can do. These contacts, particularly if they have lasted over a period of years, frequently make of the purchasing agent a mere routine order-placer. There is usually a type of purchasing which, in any case, must be reserved for the higher officials. An illustration is the purchase of expensive equipment, such as machinery.

In assembly manufacturing, the third general cause for limiting the power of the purchasing agent is a very vital one. Decisions must be continually made whether to buy or make a certain part. The answer in any given case is likely to be influenced by the state of the market at the time, the manufacturing conditions in the shop, both in regard to the need for the product and the possibility of putting it through production, and the desire to build up outside sources of supply to fill future needs. General executives sometimes feel that they are the only ones who can pass on such questions. However, if the purchasing agent be competent, and if there be provided a committee organization with a main factory committee, such matters form an excellent subject for decision there.

The purchasing agent can be advised, under such circumstances, by factory and design representatives who may be present.

In the main, under modern organization, the purchasing agent works toward the quality which is specified by the engineering or design department, and the quantity which is specified by the production or planning organization. It has already been shown that most purchases will originate through the inventory control that is maintained at the balance of stores desk, and that this control will usually be exercised from the planning department. Much money is saved by providing for purchases only at times when there are production needs. The purchase of large amounts of material because they seem cheap, or because the price is probably going up, has not generally proved to be an economy, but, to the contrary, was one of the principal causes of failure of industrial concerns during the depression of 1920. Requisition by inventory control on the purchasing department makes it incumbent on the latter to know markets, be good traders, make purchases promptly, and follow up vendors effectively. If market conditions make a speculative purchase desirable, this may always be treated separately from the usual routine of purchasing, and in any case should form a subject for general executive decision.

The authority of the purchasing department with respect to finances must be limited in all cases. It must be operated on some sort of a budget system, whether this system has been adopted for the concern as a whole or not. To require that all purchases be approved by the financial management of the concern, too seriously limits the operation of the purchasing department, but to allow it to purchase regardless of the conditions of the finances is manifestly impossible. The most effective means of controlling the financial end of purchasing work is through the operation of a general budget scheme, such as has been described. However, if there be no general budget, very effective purchasing budgets may be set up which will prevent inventories from mounting through improper purchasing operations, or through mistakes in running balance of stores sheets.

Sometimes, in the case of standard product, the purchasing department is allowed to purchase on the basis of the normal consumption for a given period, say three months. They can purchase up to this point, and then further purchases can only be made on an allotment of further funds from the financial end of the business. In unstandardized lines, the purchasing department is given a budget of so many dollars per month, and they can buy any and every type of material up to the total of moneys so allotted them. After they have reached this point they must seek further authorization before buying more. Either of these budget methods forces the purchasing agent to keep very close watch on his finances to see that he may be able to purchase toward the end of his budget period.

Regardless of the position of the purchasing department in the factory, there should always be some means provided for keeping the head of that department closely in touch with all conditions that may influence the course of his daily task, at least in the immediate future. Breakdowns in the operation of many purchasing departments can be traced to the fact that, due to sudden changes of policy, which had been developing but of which they had not been apprised, conditions of requisition so changed overnight, as to make it literally impossible for the purchasing department to properly function.

A purchasing department, whatever the extent of its powers, has certain technical functions to perform. The purchasing agent must be an all-round man, in that he must be both an office man and a factory man. To successfully operate a purchasing department involves giving careful thought to office routine and office management. At the same time, the successful purchasing agent does not spend his whole time in his own office, but is careful to be frequently in the factory in order that he may become more familiar with its needs. By this means he assures a cordial reception for his purchases from the factory men.

The tasks of the purchasing department, for which it may be held closely responsible, always include writing specifications and letting orders for satisfactory material and equipment, securing it when it is wanted at the best possible prices and on the best terms of payment, and maintaining purchase records that are accurate and complete. The last-named task is by no means the least important because it enables the others to be satisfactorily performed.

Drawing up specifications. One of the most difficult phases of purchasing department work is the drawing up of adequate specifications. The design or engineering department's requirements must govern, and yet the specifications must be in accordance with trade practice and trade terms. Specifications are most essential, if product is to be standard and if bids are to be asked for and compared. Much of the secret of good purchasing lies in drawing good specifications which vendors must live up to. It is a real money-saver, because it prevents a concern paying for a brand or trademark name, which has been built up at high advertising cost, when the same article can be purchased elsewhere at less cost. In addition, purchases may be made on a level of quality which is just good enough and not too good for the purpose at hand. Purchasing on specification is not particularly popular with vendors who have in their regular selling price the cost of establishing their trademark, but all concerns, no matter how small, can use it. Its only requirements are care in setting the specification and in inspection of goods upon arrival.

At times specifications may well be modified to suit the needs of the vendor. Thus slight and unimportant modifications of specifications

may bring considerable reductions in quoted price because the revised specifications will fall within the standard output of one or more of the vendors. Sometimes specifications are not determined by the buyer or by the vendor, but by the market. This is particularly true with those commodities which are subject to wide quotation, such as raw cotton, or staple cotton yarns and cloth. In such cases, the purchasing department can only determine the grade to be bought, and then see that the commodity as delivered comes within the market regulations for the grade ordered.

Specifications must always be set with primary reference to the manufacturing needs of the plant. Thus, one clothing firm found that by buying their fabrics in lengths of 200 yards, the cost was increased $1000 per year, because such lengths were special with the vendors, but they saved $10,000 per year in labor costs within their own plant. This factor was considered somewhat when standard materials were being discussed.

Knowing the sources of supply. The purchasing agent who makes most profit for his concern will generally be the one who is in touch with the greatest number of sources of supply, and who will get these most frequently into the bidding, either actively or indirectly. He will know the vendors who are in the best position to furnish given articles most cheaply, and he will constantly have in mind the various freight rates and discounts which will affect prices of the goods laid down at the factory door. Inviting competition is the surest way of securing the best possible prices. It is not the thought that bids should be secured every time there is an order for $10 to be let. This is perhaps the surest way of arousing the wrath of vendors, and only large plants can successfully purchase on the basis of competitive bids under any conditions. However, the door of the purchasing agent's office should be open to any salesman who desires to see him. To give the idea that the door is only open to a few favored ones is to stifle competition and ultimately bring high prices. Salesmen are trained in their product and have ideas which are valuable to the purchasing agent and to the concern which he represents. To win the favor of as many vendors' representatives as possible is to have these men working for the interests of the plant also.

The purchasing agent of a large plant in the automotive field recently cost his firm thousands of dollars because of his refusal to see a representative of a steel concern making a new, lighter steel which would have materially reduced the cost of a number of the parts of the product. Because he was in the habit of dealing through accustomed sources, he refused this salesman the opportunity of demonstrating the practicability of his product, and it was not until the latter could work through other friendly channels, some months later, that the engineering department heard of the newer steel and changed its specifications to permit of its use. The

purchasing agent may be in constant touch with the newer developments of the trade, in just this way, and may be of invaluable aid to his plant, not only through the judicious placing of orders, but through his knowledge of trade conditions.

Letting orders. In letting orders, it is essential that the purchasing agent shall know general market levels of prices, as well as the prices which he is being asked for particular materials. This will enable him to better appraise the quotations which he receives. He must have a thorough knowledge of discounts and datings which are current in the trade at the time, as well. Frequently, although reductions from list prices cannot be secured, the same effect may be gotton by an increase in the discount for cash. Particularly in times of tight money, purchasing agents who are clever can reduce the cost of purchases materially by this means. In order to know when to let orders, the purchasing agent must have a background knowledge of general business conditions. If he is not to be afraid of quickly rising or quickly falling markets, he must study trade reports and general reports of business conditions, which are readily available.

In letting orders, the purchasing agent who gives the vendor the most consideration on delivery dates will secure the most favors in the long run. Some purchasing departments have built up reputations of always putting the word " Rush " on orders. This is either disregarded by the vendor, or it puts the buyer at a complete disadvantage on price. If prices quoted are not affected on that order, they are very likely to be so affected on the next one. If the stores records are properly maintained, there will usually be no reason for asking vendors to rush most of their orders, and proper delivery dates can be set readily.

Some general managers keep careful watch over the relations of purchasing agents and vendors, with the idea that the purchasing agent is representing the concern before a large portion of the business world, and that the impression which the trade will get of the concern and the policy of the concern will largely be determined by the actions of the purchasing agent. With this in mind, restrictions as to methods of letting contracts are often put on the purchasing department by the general management. For instance, requirements as to the securing of competitive bids on large contracts are often imposed on the purchasing department quite as much on account of the impression which this makes on the remainder of the trade as to secure lower prices. Some concerns will not allow the purchasing department to let contracts to another than the lowest bidder, without consulting some designated member of the general management.

Purchasing records. The personnel of the purchasing department is ordinarily divided into two distinct classes, those actually performing the purchasing function and those in charge of the maintenance of pur-

chasing records. In large purchasing departments both these groups become of considerable size, with one or more purchasing agents in charge of the purchase of various types of commodities, and with a number of clerks in charge of the various record-keeping functions, over whom there is a chief clerk who reports directly to the head of the whole department. The work of the group under the direction of the chief clerk is of paramount importance in successful operation. Records of past transactions, as well as of current ones, are vital to intelligent purchasing. In almost no other place in management are records of what has previously happened more vital. Information files, with complete and detailed information concerning materials and vendors, can be made the very life-blood of the purchasing department.

One of the more important types of information which should be on hand, and readily accessible, is a list of manufacturers, dealers, or jobbers who are in a position to supply the articles which are regularly used, or who may be thought to be prospective bidders on any special commodities which may be required from time to time. All such information should be exceedingly complete to be of maximum value. It should include the location of the plant and the sales offices, the names of the officers to be dealt with, freight rates, any necessary remarks with reference to the freight situation between the point of shipment and the plant, such as congested junction points which may delay the shipment, and whether the concern is in a position to fill orders from stock, or must manufacture them to order. Other items of interest on these firm record cards should be facts regarding the manufacturing capacity or usual supplying capacity of the firm, and the maximum size of the orders that they can handle. Catalogues may be arranged by cross-reference to this list.

A quotation file should be maintained which will have readily available past quotations given by both successful and unsuccessful bidders. These files will ordinarily be composed of the returned "request for quotations," which have been sent out originally by the purchasing department, and will be valuable in checking over any new quotations which may be received, in settling disputes concerning reasons for granting previous orders to other bidders, and as a general bird's-eye view of the policy of the purchasing department with reference to the concerns which are invited to bid. This quotation file gives the complete history of all orders on which bids have been requested, prior to the actual filing of any of these orders. The next group of records, the actual purchase records, may duplicate some of this information, but this will not be harmful, inasmuch as when the information is wanted it will be most easily found as a quotation or as a purchase order, depending on the need at that particular time.

Purchase records are usually maintained in three ways in the most effectively run departments, namely, by firm name, by articles, and by

purchase orders. The purchase records by firms include a sort of account for each firm with whom business is carried on. This record is used to check over receipts and invoices, as well as a record on which to base the issuance of future business. In maintaining this record of purchases by firms it is most essential that all discounts and datings be carefully noted, as these will serve as a check when purchases are next made from the company in question and are quite as important as the quoted sales prices.

Purchase records by articles are useful in showing the trends of prices and in discovering whether or not bids that are received are high or low. This last is particularly true in the case of commodities and articles for which there is usually no stated "market." One error which is frequently encountered in this type of record and which must be guarded against is the placing of dissimilar commodities on the same card because of the incomplete description which is on the card or on the purchase order. This is just one more reason for making purchase orders extremely explicit. Slight differences in the article ordered may make the record of purchase by articles show fluctuations which are in fact not at all justified.

Purchase records are usually maintained in all purchasing departments by purchase order number, if in no other way. All shipments must ordinarily be marked with the purchase order number, and incoming goods are checked against the purchase order by the purchasing department prior to approving the invoice and sending it to the accounting department for payment. This type of purchase record usually consists of a retained copy of the purchase order, which copy will ordinarily have spaces for office record which do not appear on the original of the order that goes to the vendor. Such notations will include, "approved for payment," "expense distribution," "partial receipt," etc.

Another type of record which greatly increases the effectiveness of the operation of the purchasing department is the tickler follow-up of orders outstanding. This merely consists of a file, wherein special copies of the orders are placed, or separate slips bearing the order number are placed to be called to the attention of the designated person at a stated date after the papers are placed in the file. When these papers are called to the attention of the designated person, he makes an investigation to ascertain whether or not the material has been received, or what the progress has been in filling the particular order. By calling orders to the attention of a member of the purchasing staff at certain periods prior to the actual need of the material in the factory, it is possible to make certain that the material will be on hand when wanted, or at least that extra effort may be made by the purchasing department to secure it by the proper time. Thus the respect which the other departments of the organization hold for the purchasing department and its operating methods,

will be maintained and increased. In operating the tickler file, a knowledge of the vendors' businesses are of great value. If the other man's processes are known, the purchasing department can often do much to hasten action on orders. Thus one plant which had ordered some artificial stone was told by the vendor that there would have to be a delay on the order, because all molds of the proper size were in use, and would not be available for several weeks. The purchasing agent replied that he understood that it was possible to make the material by using molds somewhat larger in size and lining them, and that if the vendor did not do this immediately, he would be forced to cancel and order elsewhere. This action quickly brought results in the form of a promise of delivery on time.

Standing behind the purchasing decision. One of the most effective means of securing the long-run good-will and interest of vendor concerns is by standing behind the purchasing decision and not canceling in times of changing price conditions. The cancellation evil has come to be of great importance in some trades, and those firms which have a reputation of always taking what they order occupy a position which gives them the cream of materials and prices. Only a superhuman man can beat the market both up and down all the time, and it is usually better to win the good-will of important vendors than it is to cancel for the saving of a few dollars, providing cancellation be permitted. There are a number of ways in which vendors and salesmen can favor purchasers, such as in tips of forthcoming price adjustments and bargains in odd lots of usable materials. The concern which does not cancel is likely to be the one which secures these favors. Furthermore, if frequent cancellation is the reputation of a concern, it is likely to suffer from slow delivery, as the vendors will wait to assure themselves that the materials ordered were in reality wanted before placing them in process.

CHAPTER XXXVII

CONTROL OF SALES

Although in too many manufacturing establishments the sales department has held the balance of power to the ultimate detriment of the whole enterprise, nevertheless, it is the sales department which brings the orders that allow the business to survive. Even the most effectively organized manufacturing departments can show no results unless a steady stream of orders is being entered on the books of the company, and there are few products, no matter how high grade they may be and at what low cost they are produced which in reality "sell themselves." So, particularly in buyers' markets, the continued prosperity of a business must rest largely on the ability and effectiveness of the sales force, and the ability with which this is directed. As a factor in operation, the technique of sales and advertising is extremely important. However, this technique represents the findings of sciences almost as highly developed as those which govern the manufacturing process, and cannot become a subject for adequate consideration here. Our discussion must necessarily only cover sales from the administrative and co-ordinating standpoints and in its relation to other major functions of a business, particularly production.

Direct control of the business over the sales function must be assumed. That is, though there may be jobbers in the scheme of product distribution, these are assumed to be links in the distributive process rather than to be in a position to control the business policy. Any manufacturing enterprise which places itself in a position where its distributors may dictate what shall be manufactured and when this shall be turned out, is in a very precarious condition for long and prosperous operation. Particularly in certain textile lines, selling agents have dominated manufacture to this extent, and a usual result has been that the manufacturing plant has sooner or later been taken over by the selling agents, after which time a policy of co-ordination rather than of dictation has been instituted. There is thus assumed in the discussion of control of sales, a sales manager who shall have actual control over the means and methods of distribution, as well as responsibility therefor to the general management of the business. This sales manager, although full of enthusiasm and drive, and with the ability to go out and get business in the old-fashioned way, must also be cool and calculating and able to plan and direct the efforts of his subor-

dinates, as well as to co-ordinate their efforts with those of the production and financial staffs.

The sales manager's function. Co-ordination of sales effort with the efforts of the manufacturing departments, with the engineering or design staff, and with the financial programme of the business was seen in the chapter on budgeting to be a prime requisite for orderly administrative control of the major programme of a manufacturing establishment. It is the development of the sales schedules of this master programme and the administration of the developed schedules that we are considering now. The energies of the sales manager, in addition to his constant drive to actually sell what is being produced or will be produced, are partly taken up with thoughts of new lines of product to be developed. The design staff may be called upon by the general management to create some new product that can be produced at a given price, or that will meet some new demand of the market, but it is the sales manager who will have to pass on the practicability of the product from the selling standpoint, or on the desire of the market for given products, or on the power of the market to absorb new products. In considering these conditions, the sales manager keeps constantly in mind the necessity of meeting changing consumer demand, the creation of new demand which will be directed toward all or some of the product of his particular plant, and the constant necessity of elimination of seasonal variation in production. It should be emphasized that all of these same considerations will be of importance whether the company manufactures primarily to stock or primarily to customer's order. If the latter plan of operation be the one followed, the principal difference will be that the sales manager's task will be much more difficult, in that he will have to constantly sell and plan for sales in terms of the extent to which current orders fill particular portions of manufacturing capacity. Delivery dates on new orders that are taken must then dovetail with promises that have been made on orders which have already been turned over to the production departments for manufacture. If the plan provides for manufacture to stock, control of sales becomes somewhat simpler, although energies of the sales force must frequently be directed toward the movement of certain articles which the market suddenly rejects after the budget and manufacturing programme have been developed.

Seasonal variation in production is costly from a production standpoint, and it is killing to the morale of a working force. Yet attempts to eliminate seasonal variation may be extremely dangerous if not carefully handled. Miscalculation by the sales department may tie up large amounts of moneys in inventories of finished goods from which consumer demand has shifted. Particularly in style industries is this true, and yet in such industries the need for just such action is most important. Because of this condition, in such industries, the best plans seem to be to add lines to the

product for which there will be demand in reverse seasons, or to establish certain staple lines for which there is constant demand, and which may be manufactured when style lines cannot with safety be produced. An illustration of the first plan is found at the S. L. Allen Company, of Philadelphia, which has combined sleds and farm implements. The Dennison Manufacturing Company, of Framingham, Mass., noted for constant operation with products which are largely specialties, has mainly utilized the second plan. However, they have also attempted to create consumer demand for specialty goods at a sufficiently large number of seasons to provide for almost constant operation in these lines. The sales department can often do much to eliminate seemingly unavoidable seasonal variations by forcefully attacking trade customs of purchasing only at certain times, customs which are frequently built only on prejudice. Furthermore, through intensive sales effort, it can make successful plans such as have just been mentioned. The success of such plans lies squarely in the hands of the sales force, for unless they attempt to push supplementary lines or staple lines that have been developed, the only result will be the disastrous one of tying up capital in unmoved and increasing inventories.

Sales promotion. Effective sales control can be secured only if there be carried on definite sales promotion work, which will point the demands of the market in the direction which is desired. This promotion work in large concerns can, in its routine aspects, be handled in the main by a sales promotion department, operating only under the general direction of whosoever may be in major charge of distribution. However, the latter will be forced to lay out the major lines of operation for the sales promotion department, if he is to closely correlate their work with those of his own direct assistants, and with the administrative programme which has been laid down for the concern as a whole. The sales promotion department must be in constant touch with the salesmen or distributing agencies which are actually selling the product, and must be in a position to aid them to push a certain article in the manner which may seem most effective at any particular time. The control of advertising campaigns and appropriations can well be placed under such a department, though the actual preparation of advertisements and direct contacts with publications or printers is often left in the hands of an advertising department, or with an advertising agency.

A sales promotion department knows the customers and knows the trade thoroughly. In addition to this it knows the products which are being manufactured exceptionally thoroughly. Through the head of sales, it knows the programmes which have been laid down for a forthcoming period, and with all these factors in mind it constantly strives to promote the realization of the developed sales programme. It gives the salesmen

the home-office aid that is necessary when and where it is necessary, and in doing this it co-operates directly with the sales manager or whoever may be in direct charge of the salesmen. It maintains a stock of and distributes to dealers the various " dealers' helps " which have been devised. This also will be handled in a way which will promote any particular campaign or programme that has been determined upon.

Sales policies, such as guarantees, dealer-service, price-protection, and discounts, must all be developed so as to fit in with the promotion programme and with the general administration programme of the business. It will not avail to carry on whirlwind sales methods within the first portion of a business period in the effort to achieve some assigned quota, if this is but to result in reaction toward the end of the period that will entirely disrupt the plans of the executives. Policies of dealing with the dealers and with the public must be developed from the standpoint not only of one campaign or budget period, but of long-run results. Such policies make it possible to bring to a satisfactory conclusion the plans of any particular period, and they also make possible the setting of plans for future periods with the assurance that they can and will be carried out. If sales policies and sales promotion are carried on in this way, costly revision which affects not only the sales force, but all portions of the business, may more frequently be avoided.

Sales planning. The step which makes entirely practical the predetermination of sales effort and the resulting control is sales planning. If sales plans have been perfected, to carry them out will be but to call upon the technique of sales as developed in the sales organization through the ordinary channels of salesman-dealer or salesman-consumer relationship. Sales planning must be extensively developed before a sales programme, which will hold, can be developed. Yet some of the most effective planning must be done after the formulation of the programme and in an attempt to carry it out. There will be no attempt here to differentiate between these two types of sales planning, since there can be no practical distinction made. In laying plans to carry out one programme, lessons are learned which are of material aid in formulating the next one. Sales planning involves these steps: (1) product analysis; (2) territory analysis and construction; (3) building, analyzing, and rebuilding the sales personnel; (4) setting quotas for each branch, agency, or salesman; (5) routing of salesmen; (6) scheduling of salesmen; (7) analysis of sales results. Planning for sales which involves these steps is predicated on the thought that the sales manager must act strictly on facts, must carefully determine these facts, and must supervise his force in a way that will bring measured results from these facts.

The first step in sales planning is a careful analysis of the products to be marketed. This includes the determination of the section of the

market to which the product will appeal, the status as regards competition, both extent and kind, best methods of marketing, prices, discounts, etc. It will be seen that many of these points are ones in which the general management of the company must give advice or must perhaps make the final decision. Many others are ones in which the financial and administrative ends of the business must be consulted, as in price and discounts, while others are purely for sales department determination, as the section of the market to be attacked and the methods of marketing. On a careful analysis of each article of product is built the other steps in sales planning. If articles are manufactured to customer's order, capacities and delivery dates must be kept constantly in mind.

Territory analysis and construction involves, first of all, a decision concerning that portion of the market which is to be entered, and also the portion which is to be entered intensively and the portion to be entered extensively. Decision on such points must necessarily be made not only on the basis of the appeal which the article makes but in terms of the plant facilities and the cost of selling. If the articles produced are not extensively used, the territory must usually be a wide one. If the articles are of general use, it may be that other conditions will make it advisable to concentrate on a small portion of the country, or a few states, rather than spread effort thinly over larger territory. Cost of sales will increase as territory is enlarged, rather than as it is intensively worked. But cost of sales will also increase as a given territory is intensively worked beyond a certain most profitable point. Decisions on territory to be worked will vary continually as between products and with given products, but it is necessary to be careful that nearby profitable sales are not passed by to secure alluring but expensive sales at a distance. After deciding what territory to enter, it is necessary to determine the way in which it is to be split. Although districts or territories should in the main be created according to their purchasing power, nevertheless transportation conditions, dependence on given distribution centers, the personnel available, and the degree of intensive working that has been determined upon, all enter into the exact construction of sales zones.

In building up a sales organization many sales managers have desired to hire their own salesmen, largely with the thought that no one except a salesman can select another salesman. If the personnel department be of major caliber, there is no more logic in this reasoning than in the feeling that foremen must hire their own machine workers. A high-grade interviewer should be able to make preliminary selection of salesmen and factory workers with equal facility. Of course, if the personnel department be purely a factory organization, selection of salesmen must be left to the sales organization. Salesmen must be selected for particular territories with a view to the buyer-resistance within that territory. Polished sales-

men might succeed in one place where rough-and-ready salesmen would succeed in others. Although a really successful salesman seems to adapt himself to whatever conditions he meets, buyer resistance is cut down by properly apportioning territories among the sales force. Enthusiasm of salesmen in attaining sales goals can be stimulated by methods of payment in much the same way that interest of factory workers can be aroused, and for the same reason. Thus, in general, the payment of a straight salary or of a commission without salary, is bad. Some scheme of salary and commission payment is likely to prove the most effective. However, this must be so arranged that the entire urge will not be in the direction of increasing the amount of sales, with possible injury to net profits from sales or to customers' service. Commissions should also be based partially on the success of the salesman in reaching quotas which have been established for him. That is, compensation must be based on production, and production in turn must be determined in relation to a set task and quota. This task or quota may vary with the product, with the territory or with the salesman involved.

Setting sales quotas. To fix quotas, it is essential that territories shall have been first clearly defined, in order that they may be studied, and the fair share of projected sales apportioned. Not only for this reason, but in order to make equable the opportunities and compensations of the salesmen, territories must be clearly defined and studied. The quota itself, like any other task, should be fixed in such a manner as to be readily attainable. There is no object in setting quotas at a point which is known to be utterly out of reach. Thus the quota should be set on study, not on previous sales, or any arbitrary increase over previous sales. Such a practice as an arbitrary increase merely penalizes the salesman who has always done consistently well, and throws out of kilter the plans for total sales that are being laid. Although quotas must be fairly well worked out before the sales estimates are submitted for budget-making purposes, nevertheless they will have to be revised after the adoption of the budget to insure that its schedules are attained.

Quotas must be set with the following factors within the territory in mind. The first is the accessible population. Inaccessible population cannot be counted. Some knowledge of trade customs within the territory is involved here. On goods which are sold for household purposes such factors as the strength of mail-order houses must be taken into account, and the character of transportation facilities must be considered. On products which are used largely in trades or in manufacture, the usual channels of purchase must be thoroughly studied. The only population which is of value is that which may properly be expected to be in the market for the product. Thus, if quotas are being set on shirts retailing at $3.50, the available population is reduced considerably under that

which must be considered in setting quotas on shirts which sell for $1.50. Crude population statistics are, therefore, of little value in setting quotas, although they may be utilized as a point from which to start. The number of outlets must be determined. This may be the number of dealers, or in some cases the number of direct users of a product. Thus the quota of a branch sales office of an automobile accessory manufacturer located in Detroit would necessarily be higher than the quota of the Cleveland branch. The volume of prior sales must be given some consideration, as must the extent of competition within the particular territory. This last factor may run up cost of sales to the point where it may be desirable to abandon certain territories. The relative advertising expenditures compared with competitors must be taken into account. Market conditions within a territory should affect the quota set for it. Thus, crop failures in a farming community must affect the quota set for that community the next year for nearly all products. New sales efforts may affect all quotas, or they may affect some to a greater extent than others. If intensive advertising campaigns are to be run in certain sections, the quotas for those sections must be advanced correspondingly, as the salesman and dealer aid from this source will be considerable.

After territories have been outlined and quotas set, real control of sales demands the routing of the salesman through his territory. To allow him to haphazardly visit certain towns and skip others may mean that he is taking the path of least resistance, rather than the one of most profit. The territory should be carefully analyzed, and a route list prepared for him indicating what towns he is to visit, and perhaps, whom he is to see in those towns. Much valuable information can be secured from the salesman himself in this connection, but he should be called upon to present adequate reasons why certain towns or possible customers should be omitted from the list. Salesmen easily fall into the habit of neglecting outlets which they do not happen to like There must, therefore, be provided some means of checking calls against route lists which have been provided for them. Many firms provide an exact schedule for their salesmen, detailing exactly what calls shall be made by them on specific days, and asking for an adequate explanation of failure to make expected calls.

Analysis of sales. Sales planning must be followed by a careful analysis of results achieved, if plans are to be modified and corrected as necessary. Territories which have proved to be unprofitable must be given up. Territories which cannot be adequately covered by one man, or which might be better handled by another branch, must be changed to fit ascertained conditions. Careful study of campaigns which have been previously planned will give satisfactory information for these changes that affect subsequent campaigns. As plans become more effective, high-priced salesmen should be utilized more and more on high-priced work, and satis-

factorily directed from a home office through the utilization of low-priced clerks to aid the sales manager.

The director of distribution and the sales manager, if these be different persons, are enabled, after they have established the control which has been outlined, to co-operate more intelligently with the production executives, to truly determine their best salesmen and best branches, and to reward them accordingly. Furthermore, the sales manager is enabled to travel into difficult or highly competitive territory and to lend a helping hand to his salesmen there. He can be confident that the remainder of the men will be working toward a definite goal while he is thus helping a single individual, and he will gain much-needed knowledge of actual competitive conditions by being free to swing from under the routine of office work and work with his salesmen. Special awards, bonuses, and contests for salesmen come to have real significance if sales have been previously planned. The sales manager will find that, through these aids, he will have the concerted effort of the whole sales force bent towards the fulfillment of the sales promises which have been made to the general management and the other operating departments. Without planning and subsequent analysis, he will be playing a lone hand, endeavoring to make good on his promises, and through main strength, endeavoring to bring the members of the sales department to his assistance.

CHAPTER XXXVIII

CONTROL OF PRODUCTION

Under any form of organization there must be some control of the productive process. In its simplest form this control consists of taking bills of material or specifications to the shops, and giving these to the foremen to be made up into the product. Such bills of material usually originate in the office of the superintendent, and it is to him that the foremen are accustomed to look for advice in manufacture, and, roughly, information concerning which job shall be done first. The superintendent's office, sometimes called the factory office, thus becomes the center of information regarding jobs that are to be done, and the general sequence in which they are wanted. In such organizations, it is customary to start the material through the manufacturing processes in some such offhand way, secure in the knowledge that it will come out ultimately at the other end of the factory in the form of finished goods. Attention is given a particular order while in process only as pressure is applied by the sales department or by a customer who may demand prompt shipment. Pressure is then put upon this order by the factory office, whose representative may frequently be seen stalking over the production floors, looking for the order or its component parts, and brandishing the sales telegram. When the order is found, everything is pushed aside to give it precedence, the requirements for delivery on the other orders are forgotten or go unheeded, and thus the groundwork is laid for a series of similar telegrams in the near future.

In plants which are operated through the control of the factory office, it is but natural that the orders on which there is pressure are the ones which receive attention. Unfortunately, unless the customer is very patient, or the goods being made for stock are in no real demand, pressure is usually applied sooner or later to nearly every order, and in each case where there is a need for pressure there is likely to be dissatisfaction created somewhere along the line. Plants which operate their production forces in this manner happily are rapidly passing. In those which remain there is likely to be a prejudice against the so-called "non-producers," and the general management would rather see ten men hired for direct labor on machines than to see one clerk hired to so control the work of the other direct workers that the ten new men would not be needed. Such unwar-

ranted prejudice can only be broken down through years of painful education in mounting production costs.

The simple production department. The first step toward controlling production has usually been taken through the creation of a simple production department, which is likely also to operate under the direct control of the superintendent. This department endeavors to decrease the number of rush orders, so far as this is possible, by the creation of a master schedule of production, on which all orders are listed with the date for their completion specified. Orders thus take precedence on the basis of the date when they are wanted. The creation of such a schedule implies the development of a manufacturing order system, such as is not implied by the lesser control exercised through the factory office. These manufacturing orders may or may not correspond to customers' orders, but will probably be issued to the shop to cover profitable manufacturing quantities. The orders will be issued at such time that the work upon them may be completed by the schedule date, but with this exception the time of starting work on them will usually be left to the foremen of the departments. Besides noting the date wanted on the orders, there will usually be some broad division of these into classes, which take precedence, one over the other.

The simple production department usually provides for some sort of a progress report which will give daily or weekly checks of actual production against the schedule which has been set up. Thus the percentage of incompleted work and the capacity of the departments for further orders may be kept in mind. These progress reports give information concerning shortages of parts on various orders, and there is usually provided a force of "stock-chasers" who smooth out difficulties which may imperil the master schedule, as soon as these are seen to develop. The causes of shortages or delays may also be investigated and an attempt made to prohibit their recurrence.

This form of control deals almost entirely with problems involving when goods are due. It endeavors to eliminate production delays in order that products may come out of process when expected, and it thus forms the first and a very important step toward complete control of production. Since only the rough outlines of the production programme are presented to the shop heads, it also must frequently act after the need for pressure has been discovered. That is, drift and check-up are still possible, and there are usually a large number of rush operations which develop and must be pushed ahead to the ultimate detriment of the whole production programme.

Simple production department controlling staff work. After the creation of a simple production department it will ordinarily be found that a large share of the delays in production are due to ineffective opera-

tion of those staff functions which relate directly to production. Such functions include shop transportation, tool-room operation, and maintenance of equipment. It therefore frequently becomes logical to place the supervision of these functions in the hands of the production department, in order to correlate their activities with each other and with the necessities of the production programme. Although the emphasis of the production department is still on problems relating to when goods are due, nevertheless its control over these staff functions is a distinct step toward the creation of shop conditions which will insure goods being produced when they are due.

The planning department. The term " planning department " is often misused by being employed as a synonym for " production department." A developed planning department is far more positive in its action than is a simple production department and, on the other hand, a planning department may be only a portion of a larger production staff, the portion which does the thinking, or planning ahead. There may be other sections of the production department which aid in carrying on the developed plans of the planning section. The functions of the simple production department clearly do not include any systematic production control in advance of actual production. By far the greater proportion of its activities are of a check-up variety. That is, the department acts after it has found need for pressure at a given point in the production programme. It does not act in such a manner that this need for pressure will be eliminated. It may receive back information regarding progress, but it does not give detailed advance orders as to what the progress should be at all hours of the day throughout the plant.

The operation of an effective planning department entails an effective check on production needs prior to the actual times that these shall arise. The planning department's operation makes impossible a policy of drift and check-up. The performance of its functions demands such a fine balance of management that it will not succeed unless many other preliminary management steps have been taken and are making themselves felt fairly successfully. There must be on hand sufficient information concerning the productive processes so that work may be honestly planned ahead with some assurance that the plans can be carried out. Furthermore, conditions of work must have been established which will give the plans an opportunity to succeed. Such steps include the setting of standards, the study of jobs, attention to layout, and effective employment management.

Elements of production controlled by planning departments. If a clear understanding be secured of the factors involved in the development of a planning department which possesses the maximum of authority, it will be comparatively easy to see wherein certain phases of this authority

Type	Controls								
	Rush Orders	When goods are due (including Manufacturing Order Writing, Master Schedule, Progress Reports)	Production Staff Work (e.g., shop transportation, stores)	When Orders Start	Workplace Where work is done. (Routing)	Despatching	Department where work is done and Despatching between departments	How—Job Study	Inventories
Factory Office (Line Control of Production)	X								
Simple Production Department	X	X							
Simple Production Department Controlling Staff Work	X	X	X						
Planning Department		X	?	X	X	X	X	?	X
Production Department with Planning Section		X	X	X	X	X	X	X	X
Production Department with Decentralized Planning		C	X	C	D	D	C	X	X

X = Function performed
C = Function performed in Central Planning Department
D = Function performed in Shop Planning Units
? = Function may be performed

Fig. 83.
Chart Showing Functions Controlled by Various Types of Production Control

may be denied this department if deemed advisable. Therefore a planning department which has complete control over production will be assumed. Such control implies the centralization of control over four elements of the production process. These are (1) the manufacturing orders, (2) the material for these orders, (3) the productive equipment, including machinery, tools, and workplaces to be used, and (4) the workers.

Production planning takes these four elements, works with them, each in relation to the other, and operates through them in such a manner that the product is turned out in the time and by the method that is desired. The orders are the authorization for the performance of the work, and writing them carries with it an implication of co-ordination with the sales and financial ends of the business. The material comprises everything upon which work is to be done, whether it be raw stores, worked material, or components which are the product of another plant. The productive equipment comprises all machines, tools, and workplaces within the factory which are utilized for production purposes, and its control implies its utilization for such productive work as may be deemed best at a given time. The control over workmen is from the standpoint of the man who is to be assigned to the performance of a given task in connection with a particular order. All of these factors are co-ordinated by the planning department, so that a series of operations, based on needs of the manufacturing orders, upon capacities of equipment and workmen, and upon condition of material, are developed. These operations are then laid out, supervised and correlated in such a manner that work will proceed through the plant in the smoothest and most orderly fashion.

There is no work performed by the planning department which should not be performed by someone under any circumstances. The centralization of all similar effort under one head is but the application of the functional idea to the task of planning for production. The centralization of all planning work not only insures that it be done, but that it be done by qualified persons in a way which will be of most benefit to all within the organization. The planning department provides an opportunity for the accumulation of centralized knowledge and a utilization of this knowledge which is manifestly impossible if the planning function be unorganized and scattered among many men located in many departments.

To establish a planning department involves taking over from line members of the organization control over (1) when work is to be done, and, within limits (2) where work is to be done. The extent of control that it may exercise over these phases of the plant's activity must necessarily vary with the plant and product. In determining when and where work is to be done, the planning department performs management functions which have been given definite technical names, the use of which will

distinctly clarify any description of the work of the department and eliminate confusion of terminology. These functions are routing, scheduling, and despatching. Routing includes the planning of where and by whom work shall be done. The routing work of a planning department prescribes the path which work shall follow and the necessary sequence of operations, particularly in building up an assembly product. This work involves such close analysis of facilities that frequently layout is affected. The routing section must have constantly at its disposal all standards that have been set by job study for the operations and for shop methods. Scheduling involves the planning of the amount of work to be done and when each element of the work shall start, or the order of work. This includes planning for the quantity and rate of output of the plant or departments and also the date or order of starting of each unit of work at each station along the route prescribed. Despatching involves the meeting of schedules by proper utilization of machines, workplaces, materials, and workers, as designated by the routing. The despatching unit of the planning department thus includes all persons whose duty it is to see that orders are issued to the shop, that materials are on hand, that tools are provided, job cards issued, and, in general, that all necessary steps are taken to insure that the schedules be properly carried out.

The operation of a planning department implies the control over staff departments that is sometimes found with the simple production department, and in addition, the planning department may have control over job-study work, and usually controls inventories.

The production department with planning as one of its divisions. In large plants the planning department is usually found as a part of a larger production organization. This structure involves no radical change in the functions or methods of operation of the planning forces. Such an organization has been depicted already in the typical organization chart which has been discussed. The staff functions of production may here be entirely controlled directly by the production department, or they may be partially controlled by the planning department. In the latter case, such functions as maintenance and job study would be controlled by the production manager, while the balance of stores desk and shop transportation would probably be controlled by the planning department.

Decentralized planning control. The earlier planning departments sought for entire centralization of the various planning functions. In small concerns this is without question the desirable ideal, but in large factories decentralized control is usually found. A central department correlates the activities of the various individual planning units which are usually located in each of the producing departments of the plant. Under decentralized control the foreman is controlled by the planning department, and the planning clerk in each department may report directly to

the foreman or to the planning department. In any case he will report to the central planning department functionally. By this system the central planning department retains control of production from raw materials to finished stock, and at the same time in large plants its schedules and plans become more flexible and more readily adjusted to day-by-day and hour-by-hour happenings in the shop. This type of planning control merely provides for the removal of some of the detail planning work to the departments, without in any way reducing the correlation of major activities of the plant. The central planning department still controls the schedules and the despatching between departments. The planning supervisor in each department controls despatching within the department. Routing may be carried on in the place which seems most desirable under given plant conditions.

Decentralization of planning control brings with it relief from certain dangers which centralized control must constantly guard against. These are similar to those involved in taking the general management of a plant away from the four walls of the factory and locating it in a distant city. It is easy to get out of touch with departmental or plant conditions. It is easy to lose that co-operation of the foremen and subforemen, upon which depends, in a large measure, the success of planning work. If these men feel that orders are being sent to them for mere execution, and that the management of the plant is around them rather than through them, the planning forces are likely to lose their all-essential support. Although with central control the foremen should be in and out of the planning department all day long, decentralized control enforces the aid of foremen in planning. Thus, not only is the information collected by the experts of the planning department available, but that mass of technical information concerning production which has been accumulated by the foremen through long years of direct contact with the job can be utilized. Decentralized control should not involve supervision of clerical detail by the foreman in sufficient quantities to affect his capacity to produce. The foreman must necessarily be the responsible administrator of his department, and a certain amount of supervision of clerical detail gives him accurate information upon which to work.

Factors influencing type and authority of planning department. The extent of the authority of the planning department, be it centralized or decentralized, and the whole method of constructing its organization, must vary with the conditions of the business. These factors will govern: (1) the type of management existing, (2) the type of manufacturing in which the concern is engaged, and (3) the size of the plant. The influence of this last factor has just been noted.

All phases of management development influence the operation of production planning work. The methods of organization, the development of

standards, the extent of job study, the presence or absence of an administrative budget procedure, are all important. A good illustration of the effect of the type of management on the outlines of the planning department is found in the extent of the job studies that have been made. Job study is by no means an essential prerequisite to the operation of planning control, but the minuteness with which planning may be carried on will be directly dependent on the extent of job study data. Without job study large allowances must be made in planning work.

Planning department organization is directly affected by the nature of product manufactured. The scope of the work and the details of operation in the following industry types must of necessity be different:

1. An assembly industry manufacturing diverse products.
2. An assembly industry manufacturing standard products.
3. A continuous industry manufacturing diverse products.
4. A continuous industry manufacturing standard products.
5. Minor variations of these, especially with reference to the length of operations.

Planning departments vary in organization far more in relation to some such division of industries than they do in relation to products manufactured. Planning problems in clothing and metal-cutting manufacture, or in paper and standard textile manufacture are essentially similar. But the planning for production in a flour mill and in a lock factory have few similarities. In continuous industries manufacturing standard products, the amount of planning work which is necessary is negligible. In assembly industries manufacturing diverse products is found the most involved planning department organization.

Does production planning pay? The objection that it involves large extra expenditures for clerical labor is sometimes voiced to highly developed planning work. It does involve clerical labor. That it does not involve unreturned expense is proved by the experiences of those who have installed elaborate planning departments and have had them operating for some years. Clerical overhead may be increased but shop overhead is often decreased. One plant increased production 62 per cent and reduced overhead 21 per cent at the same time. It is not necessary that the small plant have a different person perform each function that has been or will be described. On the other hand, in large establishments, many workers are needed to handle the detail of planning. There is no fixed number of people or fixed arrangement of functions possible in organizing a planning department.

Production-planning is the answer to greater production on the same investment without unduly speeding up workers. One plant now has $2,000,000 less tied up in inventories than before its planning department

functioned. Another reports that it would have gone bankrupt with the decline of material prices in 1920 if it had had as much inventory on hand as would have been necessary without its planning department. Effective planning always means effective control of detail. It is this detail, properly co-ordinated, which makes not only for an even flow of production, but for accurate costing. This detail must be built into an effective routine without red-tape.

Although the development of a planning department must fit the individual needs of the particular plant, nevertheless there are certain planning ideas which can be universally applied, and it is these that will be considered in detail. In considering this detail, an assembly industry manufacturing diverse products will be described. Since this presents the most intricate planning problems, it forms the best basis for discussion. After considering planning work for this type of industry, the necessary modifications for other types will be discussed, and will be easily visualized. The procedure outlined can only be looked upon as a typical and well-developed one, the details and even the broad outlines of which must always be modified to fit particular conditions.

CHAPTER XXXIX

ROUTING

The scope of routing. Routing is preliminary to most other production-planning steps. Including as it does the planning of where and by whom work shall be done, the determination of the path that work shall follow, and the necessary sequence of operations, it forms a groundwork for most of the scheduling and despatching functions of a planning department. Only the development of the master schedule and the issuance of manufacturing orders precedes it. The scope of routing may be well subdivided as follows:

1. The analysis of the finished article from the manufacturing standpoint, including the determination of components in case it is an assembly product. Such analysis must indicate the materials or parts needed, whether or not they are to be themselves manufactured for an order, or whether they are to be found in stores, either as raw or worked materials, and quantity of materials needed. Much of this work may have been done by the engineering or design department in drawing up the specifications for the product, but these must be studied and checked from the production standpoint.

2. The fixing of the sequence of completion in manufacture that one part, or piece of material, bears to another, in order that all may be brought together as needed in the process of manufacture.

3. The determination of the operations which must be performed at each stage of manufacture, and where these shall be performed. This implies a division into such operations as will utilize to the best advantage both the skilled and the unskilled members of the factory's production force and all equipment. It is here that the results of job studies are of great importance. The actual selection of machines and workmen after operations have been determined upon is that portion of the routing function that is most frequently performed decentrally.

4. The division of total quantities required into proper manufacturing lots or batches. This must be done with due reference to length of operations, space occupied by the material while moving through the shop, and the requirements of the master schedule.

It is the performance of the routing function which perhaps most clearly distinguishes the work of the planning department from that of the

simple production department. It must be evident that practically all the work of routing concerns production control in advance of actual production. Why routing is desirable may be well illustrated from the problems of a textile plant manufacturing woven fabrics from a number of raw materials. In fabrics such as tapestries, the cloth may be composed of thread silk, spun silk, artificial silk, worsted, and cotton yarn, all in a large variety of colors. In such materials as madras shirtings, the number of materials may be fewer but the colors equally as great. Some of the yarns or colors in either case may be required in large lots and others in small quantities. Materials which may be needed in small quantities on one order may be used in large amounts on another. If the looms are to be kept continuously operating, all preliminary operations must be performed on each class of materials so that it will be ready for production on any order as needed. Some of these operations will have to be started a few days ahead of actual weaving, while others must be begun a month ahead. In order that schedules of production for each of the materials may be worked out, the extent of their use must be known far ahead, and the best utilization of machinery considered both in relation to these materials and the products in which they are to be used. Similarly, in manufacturing an assembly product, such as a lock, there are a number of small components, each of which must be provided in adequate amount prior to any attempt to make either subassemblies or the finished product. The raw material comprising each of these components must be put through a number of manufacturing operations prior to being available for subassemblies, and decision must be made concerning the most economical operations and machines for the manufacture of each component with due consideration to other current demands on the workmen and equipment of the shop. Since a padlock is a product which is of common usage and whose components are fairly well known, and since its manufacture clearly demonstrates the need of routing and planning work in general, it will be used largely as the basis for illustration.

There is some manufacturing where the work performed in the plant is so extremely simple, and the product is so uniform, as to require only a very simple routing mechanism, if any, after the plant once begins operations. For instance, a flour mill which operates day after day and year after year on the same type of raw material, turning it into the same type of finished product, would have but little need for an elaborate system of routing. However, even with standard product, there are usually several types manufactured, some components or materials take longer to work up than others, and thus numerous problems of routing and machine utilization arise. Although routing work is easier with standard products, still it must usually be performed as a part of current production-planning.

Inter-relation of routing, classification, and layout. In its application, routing is closely bound up with two management steps previously discussed, classification and layout. Routing and classification should be interdependent. A skeleton classification for stores, worked materials, and finished stock is of great assistance in developing routing work. And, as the route of a product is determined, components analyzed, and operations fixed, the subdivisions of a classification develop and may be recorded on the classification sheets. Ease of routing will be greatly enhanced if material symbols and operation symbols are so devised that they may be used directly in the work of routing and included in the routing instructions which are issued by the planning department.

It is not unusual to find the terms " layout " and " routing " confused. The layout of the factory, that is, the arrangement of machines, is often spoken of as routing. One of the functions of routing has been seen to be the determination of the path which materials shall take through the layout which has been devised. It is possible that much of the confusion between the two terms is due to frequent changes in layout which are occasioned after routing work is begun, due to the close study of equipment capacities that is implied in a thorough routing procedure. As the routing of a number of orders over a period of years is worked upon, layout may readily be seen to be faulty. For instance, routing work may conclusively indicate that a shop which is laid out with all similar machines grouped in one department should have the equipment arranged in accordance with the product worked upon.

Use of bills of material in routing. Routing work in a planning department begins on the receipt of a manufacturing order from the proper authority. It must necessarily be based upon the bill of material or specifications which are received from the engineering or design department. As indicated in the accompanying illustration (Fig. 84) of a section of the specifications for a padlock (see Fig. 53) this will usually give a list of the components of the product, together with specifications of the material from which they are to be made, manufacturing tolerances in case of machined parts, and frequently a list of the operations to be performed on each component. This last item may be left entirely to the production forces, but if it is, close contact must be maintained between the two departments to insure that designs do not involve unnecessary manufacturing complications.

Not only must complete specifications for the finished material be on hand before routing be attempted, but there must be much additional information available. On operations which have been previously performed, job-study data should be available for reference, and on new operations job studies must be made and the results reported back to the planning department. If there be not time for job studies on new opera-

Part	Number Required	Kind of Material	Size of Material	Gross Weight of 100-Pec. Lb.	Operation
Dog	1	Drawing steel	.075×2 1/16×C plus and minus .002	1.9148	Pierce and blank Sort Form 1st operation Light rumble in sand Form 2nd operation Rumble in sawdust Countersink dog tube hole Caseharden (done outside) Copper plate Brass plate Rivet dog tube Deliver to FS.
Case Studs	5	F. M. Yellow Brass Rod	.187D×11′ plus and minus .001	.7286	Form and cut off Whiz Rumble in sawdust Deliver to PS. .
Bolt Spring Post	1	F. M. Yellow Brass Rod	.187D×11′ plus and minus .001	.5283	Form and cut off Whiz Rumble in sawdust Deliver to PS.
Shackle Spring Post	1	F. M. Yellow Brass Rod	.125D×11′ plus and minus .001	.2442	Form and cut off Whiz Rumble in sawdust Deliver to PS.
Dog Stud	1	F. M. Yellow Brass Rod	.156D×11′ plus and minus .001	.4759	Form and cut off Whiz Rumble in sawdust Deliver to PS.

Fig. 84.—Specification Sheet or Bill of Material.

tions, then the advice of the job-study man must be secured concerning the routing of the work. He will be able to give much valuable advice from his knowledge of equipment capacities. It must not be inferred that the route man may be ignorant of the shop equipment. If routing is to succeed, the route man should be the person in the whole shop organization who knows most concerning manufacturing method. Nevertheless, he may secure much that is valuable from the job-study man and the results of his work. If routing to particular machines is to be attempted, some record of available machine capacities must be at hand. This may take the form of a rough record of the relative amount of work that is being given to each machine. Such a record will prevent preference being always indicated for some particular machine or machines if alternate choices can be made, and will enforce a consideration of the whole equipment of the shop on those in charge of routing. This record quickly indicates the approximate amount of work that the routing has at any time assigned to each machine or class of machine in the shop. In order to promote flexibility of despatching, alternate machines should be indicated in the routing wherever possible, but where there is a cost advantage in the use of one machine over another, this should be shown by designating clearly the preferred machine. Frequently, because of the nature of the operation, no preference can be shown.

Preparation of the route sheets. From the data at hand the route sheets and material for the route file are prepared. Route charts may also be prepared, as will be illustrated. Route sheets, as will be noted from the accompanying illustrations (Figs. 85 and 86), list fully the materials which are necessary for a given operation, the complete list of operations in sequence, and the machines on which these are to be performed. In addition, for despatching purposes, the standard time for each operation may be given, and check spaces are provided to record the progress of the order through the shop. Different types of route sheets are usually needed for components and for assemblies, because of the different nature of the operations involved. Material for the route file comprises all the necessary tickets and forms used in despatching the order through the shop, as provided for by the production control system and the operations that have been listed.

Route sheets serve two purposes. They indicate, for scheduling and despatching purposes, the necessary operations to be performed, and the place where they are to be performed. Through the check columns, they provide a progress report which will give at any time the status of any component, assembly, or order that is in manufacture. Furthermore, since only one lot of material is governed by a single route sheet, the work is definitely divided up into the proper lots or batches which have been determined upon as desirable from a manufacturing standpoint.

Assembly route sheets must show clearly the sequence of assembly operations, particularly whether the operation may be performed independently or simultaneously, or must be performed in sequence after another assembly operation, because it depends on the product of the latter for a

SYMBOL P2½ H1B DRAWING NO. 50936 DATE 4/7/23 WRITTEN BY F.E.W.

DESCRIPTION Back, 2½" Heavy Duty Padlock

QUANTITY IN LOT 20,000 MATERIAL SV .083 x 2 15/16 SCR

TIME PER PIECE, HRS.	PREP. HOURS	OPERATION NUMBER	OPERATION DESCRIPTION	MACHINE NO.	MOVE	OPERATION	FIRST INSP.	FINAL INSP.
			Material Apportioned and On Hand					
		1	Blank & Pile (Together with P2½H5M)	PA17				
		2	Form & Stamp	PD7				
			To Process Stores					
		3	Pierce	PD9				
		4	Straddle Mill Shackleway	MP5				
		5	Rumble in Sawdust	T2				
		6	Grind burrs on top	G7				
		7	Punch Shackleway Heel	PH4				
		8	Punch Shackleway Nose	PH5				
		9	Planish Shackleway	PD22				
		10	Trim	G4				
			To Process Stores					
		11	Rumble in Sawdust	T2				
		12	Sandblast	X8				
		13	Ebony Black Rustless Finish	X11				
			To W. M. Stores					

FIG. 85.—A Route Sheet for a Component.

SYMBOL P2½ HB DRAWING NO. 50935 DATE 4/7/23 WRITTEN BY F.E.W.

DESCRIPTION Back Assembly, 2½" Heavy Duty Padlock QUANTITY IN LOT 20,000

TIME FOR OPERATION	DRAWING NUMBER	CHECK: DEVELOPMENT ASSEMBLY	CHECK: SUCCESSIVE ASSEMBLY	ASSEMBLY OPERATION NUMBER	ASSEMBLY OPERATION DESCRIPTION	LOCATION	MOVE	OPERATION	FIRST INSP.	FINAL INSP.	STORES AND WORKED MATERIALS NEEDED FOR EACH OPERATION: QUANTITY	O. K.	DESCRIPTION
		✓		1	Rivet Case Studs & bolt spring post	R1					1		P2½H1B
											5		P2½H2B
											1		P2½H3B
			✓	2	Rivet Shackle Post	R3					1		P2½H4B
			✓	3	Rivet Dog Stud	R4					1		P2½H5B
			✓	4	Rivet Shackle Spring Post	R5					1		P2½H6B
					To W.M. Stores								

FIG. 86.—An Assembly Route Sheet.

portion of its material. To illustrate, in the assembly of a padlock (Fig. 86), the assembly of the back, is composed of one independent and three successive operations. These last operations, dependent on the first assembly having already been performed, can be carried on only in sequence. On a parts route sheet it is only necessary to indicate one lot

of raw material upon which the various operations are performed in sequence. On an assembly route sheet it is necessary to show what additional material is needed for the performance of each operation, as material may be added at various points in the assembly process.

Combination routing. Because of particular manufacturing conditions, it may be desirable to have two batches of material routed together for a certain distance through the course of manufacture, and then split. Or it may be desirable to bring together two or more batches of material at given points in the manufacturing process, although in the main they will follow separate courses. Such conditions usually call for combination routing, which provides for the routing of the various batches so that their relation one with the other will be clearly evident. An example of the necessity for such routing is found in assembly industries not making standard products, in which materials must be brought together at various stages in the process to insure that rivet holes and other similar points which must come into direct contact in the finished product will match. To provide for this, the various components of the finished product must be routed co-ordinately in such a way that they will go through a number of operations separately and will then be moved as the next operation to some central point, in order that the rivet holes may be matched. They may then break apart again and go through various other operations prior to again being brought together in assembly. Combination routing is also provided for several jobs in production, which may use the same set-up on any machine. In order to save time and set-up cost, these jobs will be routed in combination.

Preparation of tickets for despatching. A portion of the routing function usually includes the preparation of the route file, which includes all tickets needed for planning and despatching work during the course of the order in the shop, such as time and job tickets, issues for worked materials and stores, operation orders, inspection tickets, and move tickets or tags. These tickets, which are usually written in the main by some duplicating process, are suitably taken care of by some filing scheme until they are needed for despatching. Sometimes they are all placed in pockets in a specially constructed file, which will contain all route sheets and papers pertaining to one manufacturing order. Thus the route file will contain information concerning the path that that order is to take through production, plus all necessary forms which will be utilized in despatching, working, paying for labor on, or recording costs, for the order, plus the necessary columns on the route sheet to accurately record the progress of the order. To these often will be added tool lists to be sent to the tool room as given operations are called up in the process of despatching, and instruction cards to be issued to the workmen as the operations are to be performed. Route sheets are at times arranged in the form of a visible index, so that

they may be easily referred to by the despatcher, in which case the necessary forms are filed close by in boxes or tub desks (Fig. 87). The use and issuance of the various papers which are prepared will be described under the order of work and despatching procedure (Chapter XLI).

Close inter-relation of routing and scheduling. Although routing presumes the best possible utilization of equipment, still it is desirable in routing work to closely observe the conditions of the plant schedules, and

FIG. 87.—Route Sheets (in foreground) and Machine Boxes (in rear, along wall), Universal Winding Co., Providence, R. I. (Note the boxes containing despatching forms, located below the route sheets.)

not leave too much leeway in the selection of equipment and too much of the adjustment function to despatching, which is largely a routine, clerical job. In routing, attempt is always made to prevent the utilization of a large, expensive machine for a small job that can be done on a small machine, and yet if the schedule of work is not providing operations for the large machine, and is over-crowding the small one, the route man must take this into account in designating the path that material shall follow. Although he desires to always use the machine which is best fitted for a

particular operation, still there is ordinarily no object in having machines idle while others have jobs waiting. The machine record already referred to will aid in correlating scheduling and routing, and if the route man has an opportunity to study a report of idle machines which gives reasons for idleness, it will aid him in routing with the needs of the schedule in mind.

Any routing work must necessarily be carried on with some thought as to the relative time at which various operations or the manufacture of various components must be begun. This was indicated in the reference made to the textile plant. Thus again must the schedule be kept in mind, and this is in addition to a consideration of the mere sequence in which operations be formed. Sequence does not take into account the time element, or the length of the operations involved, and yet this must be kept constantly in the forefront of the route man's considerations.

Use of route charts. Standard route charts, which set forth graphically, in definite order, the operations, materials, machines, and grades of labor required to make a finished product in the most economical manner, are frequently utilized (Fig. 88). They serve as a permanent record, and as a guide in the drawing up of route sheets for individual orders. They are most practicable with standard repetitive product, but can be used profitably in any plant where the sequence of operations is similar, although particular operations may vary. On such charts the operations are so set forth that their sequence is made perfectly clear, and, in the case of assembled products, that the sequence of assembly of the various parts is carefully shown. All independent groups of the finished product are so separated that those operations which may be performed independently may be seen at a glance. The amount of information which is placed upon the chart may best vary with the needs of the plant. Generally the following information is included: materials needed, with symbols; operations, with numbers; and best machines or equipment for their performance. At times alternate machines are designated upon the chart, in which case the estimated relative costs of performing the operation on the alternate machines may well be included in order to eliminate the tendency to utilize the most costly machine.

Combination schedule and route charts provide for the charting of all operations and assemblies in proper sequence upon a scale, which is so computed toward the left from final assembly that reference to the chart will indicate exactly when any component must be placed into production. This chart is so devised that the necessary operations upon components and the subassemblies into which they go may be performed in time to have them meet with other components for semifinal or final assembly on schedule. Such a chart is extremely valuable if shop conditions permit of a smooth flow of work. Sufficient time must be allowed between operations, in laying out such a chart, that goods may be inspected and

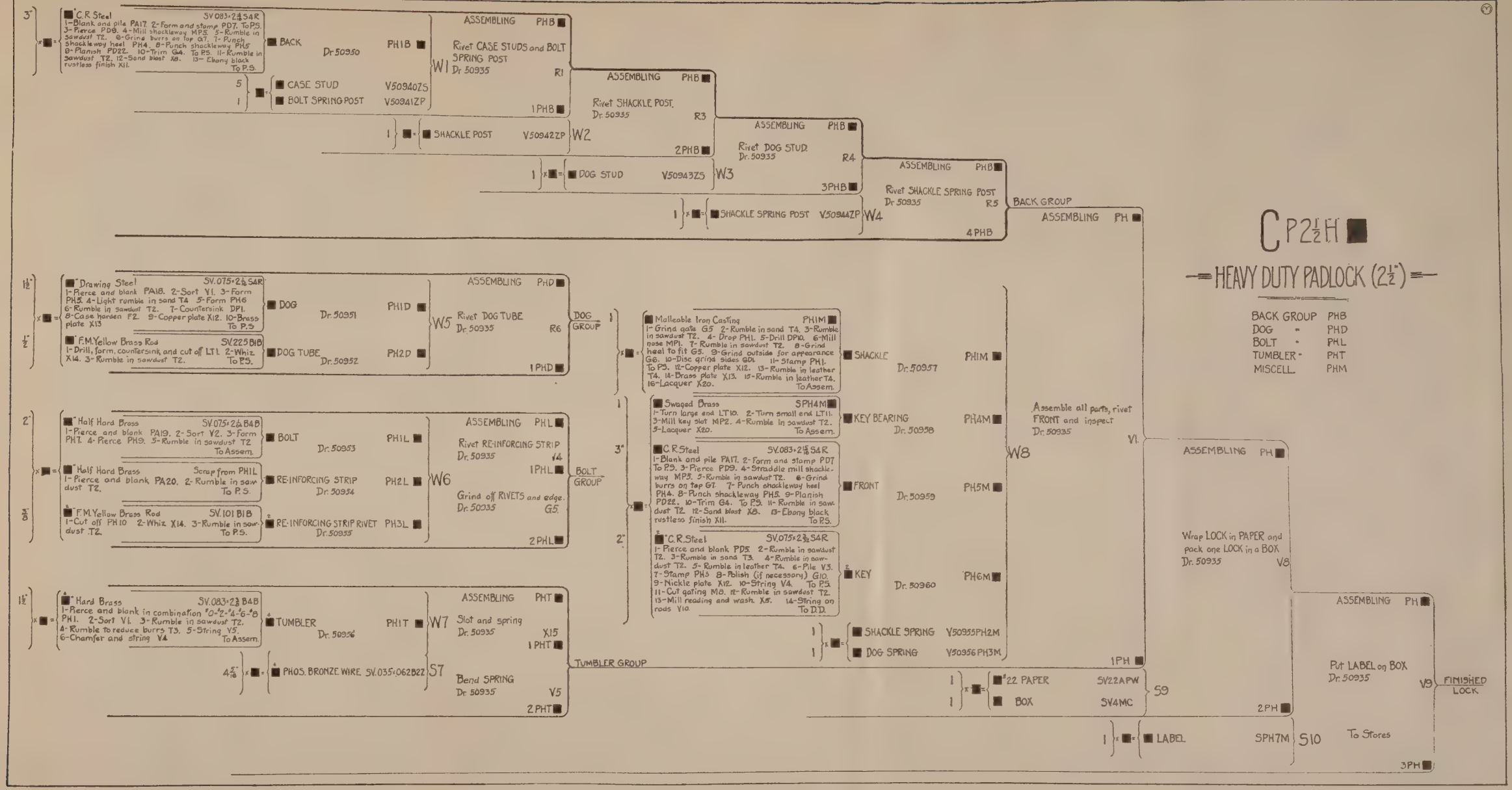

C P 2½ H
HEAVY DUTY PADLOCK (2½")
BACK GROUP PHB
DOG - PHD
BOLT - PHL
TUMBLER - PHT
MISCELL. PHM
C.R. Steel SV.083×2⅛S4R
1-Blank and pile PA17. 2-Form and stamp PD7. To P.S. 3-Pierce PD9. 4-Mill shackleway MP5. 5-Rumble in sawdust T2. 6-Grind burrs on top G7. 7-Punch shackleway heel PH4. 8-Punch shackleway PH5. 9-Planish PD22. 10-Trim G4. To P.S. 11-Rumble in sawdust T2. 12-Sand blast X8. 13-Ebony black rustless finish X11. To P.S.
BACK Dr.50950 PH1B
CASE STUD V50940ZS
BOLT SPRING POST V50941ZP
ASSEMBLING PHB
Rivet CASE STUDS and BOLT SPRING POST Dr.50935 R1
W1
1 PHB
SHACKLE POST V50942ZP W2
ASSEMBLING PHB
Rivet SHACKLE POST Dr.50935 R3
2 PHB
DOG STUD V50943ZS W3
ASSEMBLING PHB
Rivet DOG STUD Dr.50935 R4
3 PHB
SHACKLE SPRING POST V50944ZP W4
ASSEMBLING PHB
Rivet SHACKLE SPRING POST Dr.50935 R5
4 PHB
BACK GROUP
Drawing Steel SV.075×2½S4R
1-Pierce and blank PA18. 2-Sort V1. 3-Form PH3. 4-Light rumble in sand T4. 5-Form PH6. 6-Rumble in sawdust T2. 7-Countersink DP1. 8-Case harden F2. 9-Copper plate X12. 10-Brass plate X13. To P.S.
DOG Dr.50951 PH1D
F.M. Yellow Brass Rod SV.225 B1B
1-Drill, form, countersink and cut off LT1. 2-Whiz X14. 3-Rumble in sawdust T2. To P.S.
DOG TUBE Dr.50952 PH2D
W5
ASSEMBLING PHD
Rivet DOG TUBE Dr.50935 R6
1 PHD
DOG GROUP
Malleable Iron Casting PH1M
1-Grind gate G5. 2-Rumble in sand T4. 3-Rumble in sawdust T2. 4-Drop PH1. 5-Drill DP10. 6-Mill nose MP1. 7-Rumble in sawdust T2. 8-Grind heel to fit G8. 9-Grind outside for appearance G6. 10-Disc grind sides G10. 11-Stamp PH1. To P.S. 12-Copper plate X12. 13-Rumble in leather T4. 14-Brass plate X13. 15-Rumble in leather T4. 16-Lacquer X20. To Assem.
SHACKLE Dr.50957 PH1M
Swaged Brass SPH4M
1-Turn large end LT10. 2-Turn small end LT11. 3-Mill key slot MP2. 4-Rumble in sawdust T2. 5-Lacquer X20. To Assem.
KEY BEARING Dr.50958 PH4M
C.R. Steel SV.083×2⅛S4R
1-Blank and pile PA17. 2-Form and stamp PD7. To P.S. 3-Pierce PD9. 4-Straddle mill shackleway MP3. 5-Rumble in sawdust T2. 6-Grind burrs on top G7. 7-Punch shackleway heel PH4. 8-Punch shackleway PH5. 9-Planish PD22. 10-Trim G4. To P.S. 11-Rumble in sawdust T2. 12-Sand blast X8. 13-Ebony black rustless finish X11. To P.S.
FRONT Dr.50959 PH5M
C.R. Steel SV.075×2⅜S4R
1-Pierce and blank PD5. 2-Rumble in sawdust T2. 3-Rumble in sand T3. 4-Rumble in sawdust T2. 5-Rumble in leather T4. 6-Pile V3. 7-Stamp PH3. 8-Polish (if necessary) G10. 9-Nickle plate X12. 10-String V4. To P.S. 11-Cut gating M3. 12-Rumble in sawdust T2. 13-Mill reading and wash. X5. 14-String on rods V10. To D.D.
KEY Dr.50960 PH6M
SHACKLE SPRING V50955PH2M
DOG SPRING V50956PH3M
W8
Assemble all parts, rivet FRONT and inspect Dr.50935 V1.
ASSEMBLING PH
Wrap LOCK in PAPER and pack one LOCK in a BOX Dr.50935 V8
ASSEMBLING PH
Put LABEL on BOX Dr.50935 V9
FINISHED LOCK
3 PH
Hard Brass SV.083×2⅜B4B
1-Pierce and blank in combination 0-2-4-6-8 PH1. 2-Sort V1. 3-Rumble in sawdust T2. 4-Rumble to reduce burrs T3. 5-String V5. 6-Chamfer and string V4. To Assem.
TUMBLER Dr.50956 PH1T
W7
ASSEMBLING PHT
Slot and spring Dr.50935 X15
1 PHT
PHOS. BRONZE WIRE SV.035×.062B2Z S7
Bend SPRING Dr.50935 V5
2 PHT
TUMBLER GROUP
Half Hard Brass SV.075×2⅛B4B
1-Pierce and blank PA19. 2-Sort V2. 3-Form PH7. 4-Pierce PH9. 5-Rumble in sawdust T2. To Assem.
BOLT Dr.50953 PH1L
Half Hard Brass Scrap from PH1L
1-Pierce and blank PA20. 2-Rumble in sawdust T2. To P.S.
RE-INFORCING STRIP Dr.50954 PH2L
F.M. Yellow Brass Rod SV.101 B1B
1-Cut off PH10. 2-Whiz X14. 3-Rumble in sawdust T2. To P.S.
RE-INFORCING STRIP RIVET Dr.50955 PH3L
W6
ASSEMBLING PHL
Rivet RE-INFORCING STRIP Dr.50935 V4
1 PHL
Grind off RIVETS and edge Dr.50935 G5
2 PHL
BOLT GROUP
"22 PAPER SV22APW
BOX SV4MC
S9
2 PH
LABEL SPH7M S10
To Stores
3 PH

Fig. 88.—A Route Chart for a Padlock.

To face page 436.

moved. This time is usually arbitrary and the same for all operations and departments. It must be so regulated that orders will move at the greatest possible speed, to prevent unduly large inventories of material in process, and nevertheless so that there will be a factor of safety remaining. Many production control boards have been worked out on this principle, and are in reality only such a chart in board form. The best known of these boards is that of the H. H. Franklin Manufacturing Co., of Syracuse, N. Y.[1]

[1] See "Taylor System in Franklin Management," G. D. Babcock, Engineering Magazine Company, pp. 63*ff*.

CHAPTER XL

SCHEDULING PRODUCTION

Scheduling production provides for the setting of beginning and completion dates for each manufacturing order or portion of a manufacturing schedule, and for the determination and rearrangement of the order of work within the shop so that the completion dates may be met. The most familiar form of schedule control is that of the railroads. The processes of industrial scheduling are essentially similar. Predetermined schedules control the operations of the offices of railroad despatchers. Similar schedules control the despatchers of industrial production. In developing the railroad schedules, limited, express, and local passenger trains, through freights and way freights must all be placed upon the schedule in such a way that they may utilize the same tracks most effectively. Provision must be made, through the despatcher's office, to schedule special trains, and to rearrange schedules or sequences of operation as trains become late and peculiar circumstances interrupt the ordinary conditions of operation. Factory scheduling involves essentially the same elements. There are regularly scheduled orders to be taken care of, each of varying importance. Then there are special orders and special conditions to be met, as shop conditions change or as the regular schedule is interrupted. The equipment of the factory is almost as limiting to the passage of orders one around the other as are the rails of the railroad. And orders must be scheduled and schedules must be changed to meet conditions, if the demands of production and the requirements of sales are to be met. That is the function of scheduling.

There are two distinct phases of production scheduling. The first is a carefully drawn master schedule which indicates the relative importance of manufacturing orders. This may be developed prior to or coincidently with routing. The second is the determination of the order of work, or the exact order of operations of each portion of each order that is performed at a separate workplace. This phase of scheduling follows routing in performance, and is carried on either prior to or coincidently with despatching. The determination of the order of work is primarily a scheduling function. The operation of the order of work is primarily a despatching function. Inasmuch as they are frequently carried on coincidently, it is difficult to entirely separate discussion of the two.

However, in so far as they may be separated, the understanding of the planning function in its elements, rather than in a particular installation, will be clarified.

Master schedules of production. In scheduling production, manufacturing orders originating from direct customers' orders, or as a part of manufacturing budgets, must be so arranged that the plant may be operated at its maximum manufacturing effectiveness. If possible, each productive unit should so be provided with work as to allow it to be operated continuously. But, primarily, sales requirements must be met. The work of scheduling comes into more direct contact with the sales department of the business than does that of the other planning functions. General policies regarding the relationships of sales and production are determined by the general management, by budget meetings, or by the daily contacts of the production manager and the sales management. In large plants, the production manager may deal more with broad policies than with specific sales orders. In such cases the arrangement of the production schedule may be entirely a function of whoever is in direct charge of scheduling production. Manifestly, in small plants, the production manager will himself directly control scheduling.

In the development of a master schedule, it is essential that there be careful co-operation with the sales department, not only that information concerning sales needs from the delivery standpoint may be considered, but also that information concerning prospective orders may be secured. This is particularly necessary in cases in which a plant manufactures both to customers' orders and to stock. This indicates that if the production manager does not directly control scheduling, whoever does must sit, along with the production manager, on such committees as deal with the co-ordination of efforts of the sales and production departments.

Issuance of manufacturing orders. Manufacturing orders, based on the master schedule, will usually be issued as a part of scheduling work. These orders may be subject to subdivision into economical manufacturing batches by whoever is in charge of routing; nevertheless, they will usually be issued with full consideration of this factor. A single manufacturing order may cover only a portion of the manufacturing budget for a particular article, or it may combine two or more customers' orders for the same article. Thus small customers' orders or large stock orders are increased or subdivided into profitable manufacturing quantities. The shop does not care who gets the finished product. It does want to know how much is wanted and when it is needed. This is fully described on the manufacturing order, and the due date which is placed upon it, corresponds to the sequence on the master schedule. An effective manufacturing order blank is illustrated in Fig. 89. It is thus clear that the master schedule must be so arranged as to indicate (1) the due date of all orders, (2) group-

ings of orders into broad classifications of importance, and (3) subdivisions of groups in accordance with particular circumstances, such as the time required to manufacture.

Master schedules—plants manufacturing to customer's order. There is no hypothetical grouping of classes of orders that will be fully satisfactory in any and all plants. Nevertheless, those in charge of scheduling must be governed by the same general considerations, regardless of the plant. In plants manufacturing primarily to customer's order, these orders will be seen to subdivide themselves into some such general classes

L. M. Co. SF 48 A AP G. A.G. Co. 9162 **PUT-UP MANUFACTURING ORDER**

PLEASE FINISH THE FOLLOWING:

ORDER ISSUED			ORDER WANTED			ORDER DUE			ORDER FINISHED		
MONTH	DAY	YEAR	MONTH	DAY	YEAR	MONTH	DAY	YEAR	MONTH	DAY	YEAR
		19			19			19			19

QUANTITY IN LOT	KIND OF UNIT	GRADE	SYMBOL	DESCRIPTION

REMARKS: _____

SIGNED _____

MANUF'G ORDERS for which these goods are needed	MANUF'G ORDERS for which this order is waiting	QUANTITY FINISHED				SHIPPING ORDERS awaiting completion of this order	TICKLER DATES					
		Firsts	Seconds	G. E.	Date		MONTH	DAY	MONTH	DAY	MONTH	DAY

ORDER WRITTEN		ROUTING LAID OUT		BILL OF MATERIALS PREPARED		MATERIALS APPORT'D AND REQ. WRITTEN		MACHINE RECORD		PROMISED DATE DETERMINED		ROUTE FILE PREPARED		COST SHEET WRITTEN		MATERIAL DELIVERED AND WORK STARTED		WORK FINISHED		BALANCE CARDS		MACHINE RECORD		COST PREPARED	
DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR

FIG. 89.—Manufacturing Order.

as the following: rush, regular, repair, and stock. Any order falling into one or the other of these classes will, in general, be given precedence in accordance with the class in which it falls, in the order just enumerated.

Rush orders include those which are received with necessary delivery dates so stipulated as to make these prior to the time at which the product would naturally be completed in the ordinary course of production. Whatever the desires of executives, this class of orders seemingly never can be completely eradicated. Rush orders also come to include those on which there has been a tie-up somewhere in the production process, which has thrown the individual order back of its previously determined schedule. By regular orders are meant customers' orders which are received with

delivery dates specified that fit into the usual requirements of factory production. Such orders ordinarily take precedence over repair orders on goods already sold, although there may be circumstances when these latter will come even into the rush class. If there are many repair orders, they may well be put through on an entirely different manufacturing basis, and, in large plants, in different departments than regular orders. Stock orders are usually utilized to fill in the voids between orders intended for certain customers. They cover staple products, for which there is a constant demand.

Master schedule—plants manufacturing to stock. The sequence of classes of orders must necessarily be different in a plant which manufactures primarily to stock. The development of product standardization within recent years has greatly increased the number of such plants, and the spread of the idea of the administrative budget will further increase them. In a factory which manufactures a variety of standard products for stock, from which customers' orders are filled as they come along, there is usually developed a production budget or "demand estimate procedure." This carefully drawn estimate of production needs, such as has already been discussed, serves as the basis for the development of the master schedule. If a plant be on such a manufacturing basis, it has achieved a flexibility of scheduling such as is not possessed by the factory which operates primarily to customers' orders.

The manufacture of materials for stock implies even a closer liaison with the sales department than does the production of orders to directly fill customer's demand. It also implies a closer relationship with the policy control of the company, since, in order to schedule product which has not yet been sold, it is necessary to have a definite knowledge of future company sales and production policy, as well as a knowledge of the financial affairs of the plant. It is not to be assumed that those in charge of the preparation of the master schedule will have all of this knowledge. They will, however, be governed by their demand estimate procedure, which will have been so worked up as to include this detailed knowledge of company policy whether or not there be a general budget.

Companies which wish to avoid production tie-ups and which operate on the basis of manufacturing to stock, usually have their schedules developed months in advance. Unless there is some arrangement made whereby these schedules may be readily changed, it is very likely that financial difficulties may be encountered because of the working capital which is tied up in material. The close liaison necessary between the scheduling function and the balance of stores function must be evident. There must be continual conference between those in charge of these two phases of control.

In manufacturing to stock, customers' orders are usually regarded as

special and not allowed to interfere with the regular schedule. However, the rush order still persists. It is probably clear that the necessity frequently arises, during the progress of an order through a shop, to change it from one status to another, thereby changing the precedence accorded it.

The master schedule should not be looked upon as something rigid into which a new order finds a definite place upon its receipt in the shop, that place never to be changed. On the contrary, it should be regarded as a continually flexible piece of shop mechanism, which is changed week by week, perhaps day by day, as conditions change with the receipt of new orders, the completion of old ones, or the development of some new condition in the shop.

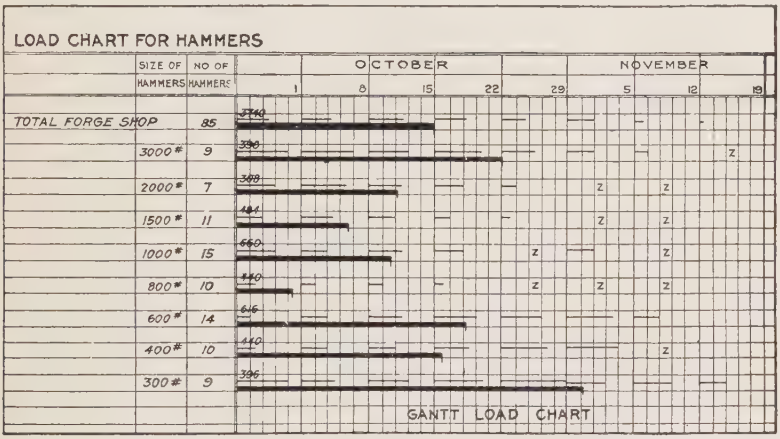
To have a flexible system that permits a slight change of the class of an order during its progress of manufacture eliminates the necessity of actually tagging orders "rush." In some shops, where the classification of orders has not been well worked out, and where orders are not moved from class to class, but are merely pushed through by strength of stock-chasers or some similar method, it is common to find the word "rush" degenerate in its meaning because of the addition to it of such words as "special" or "extra." Sometimes, instead of an orderly process of scheduling which will determine exactly which order will be put through first, there is developed such a monstrosity as an "extra-special rush" order. If classes of orders are clearly defined, and then freedom is given to move orders within those classes in accordance with needs, the control over the time of doing work will soon be found to become orderly and such designations to be unnecessary.

Master schedule based on standard hourly production. If job studies, or analyses of machine capacities have been made in detail, data can be worked out which will give the standard hourly production for a given machine or a given department, or on a given operation. These data may be used to set up a master schedule. If the product be standard it may be desirable to set up a schedule board, that will give in detail the time of starting and stopping of each major operation on each part which goes into the product. It is wise to set up such a board on the basis of something less than 100 per cent efficiency. Progress reports which come from the production departments may then be checked with the master schedule that has been set up, and the order of work changed to rectify any undesirable conditions.

On unstandardized, diversified product, the master schedule may be set up in terms of hours of work ahead on given classes of product. Such information, which may be termed the balance of work ahead, can be easily communicated to the sales department. In making sales, the sales department can deduct the time required for their manufacture from the balance and thus can always know the unfilled capacity of the plant which

it may sell. Means of filling unsold capacity in special work can be discussed at meetings of the general factory committee or in other suitable conferences. Such a programme involves determining everything in terms of hours of time it takes to produce product, by departments. The sales department must be kept constantly informed concerning this. In a sense the sales department sells departmental time rather than products, and the scheduling work is concerned with time rather than with products. The operation of such a schedule is greatly facilitated through the use of a load chart which will indicate unapportioned capacities by departments and types of machines.

The load chart. The creation of a schedule based on standard hourly production, and the ability of a sales department to keep manufacturing



Courtesy Wallace Clark and The Ronald Press.

Fig. 90.—Load Chart for a Drop Forge Department.

departments constantly supplied with orders, is greatly enchanced through the use of Gantt Load Charts, similar to the illustration (Fig. 90). This chart was prepared by Mr. Wallace Clark and is reprinted by permission from his book, " The Gantt Chart."[1] It illustrates the scheduled load of a forge shop. The first line of the chart indicates the total work ahead of the shop, by weeks and as a grand total. The other lines indicate the amount of work scheduled ahead for each class of hammers, by weeks and in total. The figures, 396, 308, etc., indicate the weekly capacity of each group of hammers, based on a 44-hour week. Thus the chart indicates that the 3000-pound hammers have enough work scheduled for them the first week to keep them busy 80 per cent of the time, as indicated by the

[1] "The Gantt Chart," Wallace Clark, The Ronald Press, pp. 77–80.

light line, while for the week ending November 5 only 40 per cent of their capacity had been booked, and zero had been booked for the week ending November 19. In general, if material and tools were available, these hammers could continue steadily for four weeks on orders already booked. The shop as a whole had 50 per cent of its capacity booked for the first week and a total of three weeks' work ahead.

The order of work. The preparation of the order of work differs from the development of the master schedule, inasmuch as it concerns itself with detailed operations of manufacture of a product, rather than with the completed product. The control exercised by the master schedule throws emphasis on bringing the final delivery date to such a point as to coincide with the needs of the sales department. The development of the order of work should control the step-by-step progression of the work through the factory in such a way as to bring the finished product through the process of manufacture at such a time as to meet the needs which have been set down by the master schedule. Changes are but infrequently made in the master schedule as compared to changes in the order of work. The latter feels the ebb and flow of factory conditions. A particular machine may be broken down, a particular workman may be out, and these may change the order of work on another machine or for another workman, in order that the needs of the master schedule may be met. On the other hand, such small recurring factors do not in any way affect the master schedule.

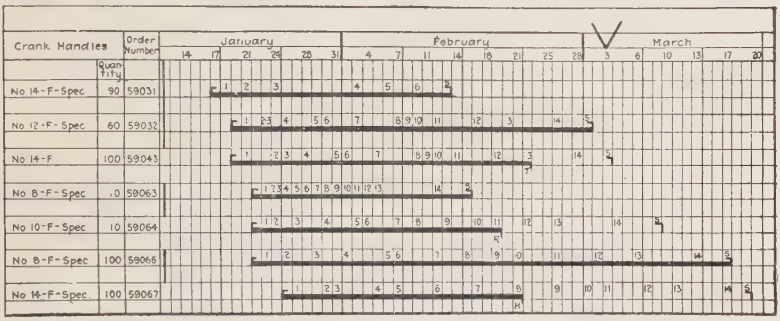
In the development of the master schedule, the orders must necessarily be arranged in accordance with their relative importance. In arranging the order of work, the operations must be arranged in such a way as to consider the amount of work which must be done on each and the conditions which exist in the shop, as well as the date when the final work on each order must be completed.

Progress charts as an aid in scheduling. The method by which the scheduling division receives the information on which to base changes in its order of work is through the creation of a system of progress reports or progress charts. These give up-to-the-minute information concerning the progress which has been made on various orders that have been started through the process of production and which, therefore, have already been given a place in the order of work. If progress charts indicate that any order or any part of an order is falling behind the schedule, steps are immediately taken to advance this order or section of an order to a higher position in the order of work.

The Gantt progress charts. The most effective type of progress chart is the Gantt Chart. The two accompanying illustrations are reproduced by permission from Mr. Wallace Clark's book, "The Gantt Chart."[1]

[1] "The Gantt Chart," Wallace Clark, The Ronald Press, pp. 87–94.

Figure 91 represents a progress chart used in a machine shop manufacturing to customer's order. The angle opening to the right indicates the date on which each item was to be issued from stores; the figures indicate the numbers of the operations to be performed on each order and are placed under the dates on which they were to be begun, and the angle opening to the left indicates the date on which the parts were to be shipped. The heavy lines indicate what operations have been performed on each order, and the letters under the lines indicate the reasons for delay. The R under order 59064 indicates delay due to repairs, and since the chart indicates the time needed for the remaining operations, adjustments in the schedule can be made by the production manager to meet existing conditions. The V indicates that this chart was reproduced on March 3. If the work had proceeded exactly according to schedule, the heavy lines for all operations



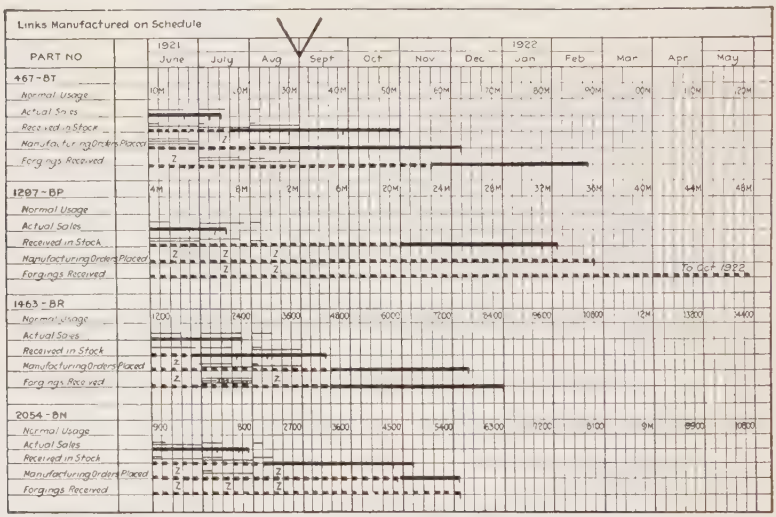
Courtesy Wallace Clark and The Ronald Press.

FIG. 91.—Progress Chart Used in Machine Shop Manufacturing to Customers' Order.

due to be completed on that date would end exactly under that date, except on those operations scheduled for prior completion. It will be noted that certain orders were ahead of, and certain ones behind schedule. Figure 92 represents a progress chart used in a plant manufacturing to stock. The figure at the left of a monthly space is the amount scheduled for each month, the figure to the right indicating the amount scheduled to date. The work done each month is indicated by the light line, and the work done to the time of the preparation of the chart by the heavy line. Work done prior to June 1, when the chart was drawn up, is indicated by the dotted line. Z signifies zero for the month. On part 1463–BR the sales schedule was set at 1200 per month. However, the amount of sales during the first three months fell short of this estimate. There were 960 in stock when the chart was drawn and during June 1050 were received, in July 720, and in August 1440, or a total of $3\frac{1}{2}$ months' normal usage, as indicated by the heavy line. Deducting sales, $1\frac{3}{4}$ months' normal usage is found to remain in stock. The heavy line on manufactur-

ing orders placed indicates that this covers $2\frac{1}{2}$ months' normal usage beyond the articles already placed in stock, while the number of forgings on hand is sufficient for more than another half-month's production.

It is necessary that this check-up by means of progress charts, or otherwise, be made a continuing process and one that is always kept up to the minute, because parts of assemblies, or whole orders, which once get very far behind schedule usually will throw many others out of schedule if the effort is made to bring them back into position. The effect of having to put extra pressure on one order is usually to require placing at least slightly extra pressure on a number of others later. It is the prompt



Courtesy Wallace Clark and The Ronald Press.

Fig. 92.—Progress Chart—Manufacturing to Stock.

checking-up of orders falling behind a carefully worked-out schedule that keeps the whole shop on its toes. For instance, if the delay is due to the lack of arrival of material, there should be an automatic check on the man who has the job of getting the material in. If the delay is due to equipment out of commission there should be a strong pull on the superintendent or the maintenance man to give his personal attention to that particular portion of the equipment.

Scheduling's relation to the plant executives. It will be well to understand the relationship of the foremen of the shop to the order of work. Ordinarily, the foremen do not come into actual contact with the order of work, as such, but only through the information that they receive from the despatchers, which is in turn based on the order of work that has been

prepared. Still, if the foremen were at liberty to disregard the orders from the despatchers, the order of work would be quickly upset. A floor foreman may not change the order of work although he should advise its change if he thinks that necessary. If for any reason he feels that he cannot carry out the work as despatched, he will notify the despatcher, who will take the matter up with whoever is in charge of scheduling. The latter will then adjust the matter with the foreman in such a way as to provide for necessary changes and still maintain the relative position of the particular order by means of other adjustments.

The work of scheduling heads up in reports given to the works manager and other major executives of the concern. Besides a " balance of work " or " load ahead " report, which indicates unapportioned capacities, reports at periodical intervals may be made by the scheduling division which show:

1. A detailed list of all customers' orders in process.
2. A detailed list of all stock work in process.
3. A detailed statement of causes of delay or changes in the order of work which have held up production and which may be remedied or bettered by executive action.

CHAPTER XLI

OPERATION OF THE ORDER OF WORK AND DESPATCHING

To operate the order of work is to clearly signify for each machine or workman the sequence in which jobs are to be performed, based on the needs of the master schedule and conditions in the shop. Despatching includes the execution of all the plans of the routing and scheduling sections of the planning department. It largely consists of transmitting orders to the shop, is carried on coincidently with the operation of the order of work, but is purely a clerical function. Although, except in large plants, the operation of the order of work and despatching are likely to be carried on by the same individual, for clarity of illustration they will be spoken of as if handled by two persons.

Central operation through the use of planning boards. In order to clearly understand all factors involved in these phases of production control it will be best to first consider one basic system. This system will presume central operation of all phases of planning in a shop wherein the nature of the product and orders make necessary complete control of each separate operation. The type of jobs and size of lots will be such that the operations will be long enough to make such control profitable, and yet short enough to allow at least three jobs to be constantly planned ahead of each machine or workman. Changes in these basic conditions would necessitate changes in the system devised, such as will later be indicated. This system will clearly indicate the factors in production which must in some manner be controlled by the order of work and despatching. These factors will be seen to include the workmen, the equipment, raw and worked material, tools, instructions, inspection, and shop transportation. To study this system is particularly valuable because it clearly controls each of these factors separately, and thus clarifies systems which combine control over several factors in production. The fundamentals of this system are probably used in more planning departments than those of any other, and many other planning systems are clearly developments which use this one as a basis.

The greatest aid in operating an order of work is some sort of continuous visual check on the condition of the shop. The type of check here described is known as a bulletin board, or planning board (Fig. 93). Through the operation of this bulletin board or its equivalent, those in

charge of the order of work and despatching have always before them an accurate picture of shop conditions, and through the added aid of the route sheets, the status of all orders. The planning department bulletin board pictured on the attached illustration is known as the three-hook type. Pairs of hooks are arranged in vertical rows in sets of three for each machine or work station. Each pair of hooks is utilized to indicate the

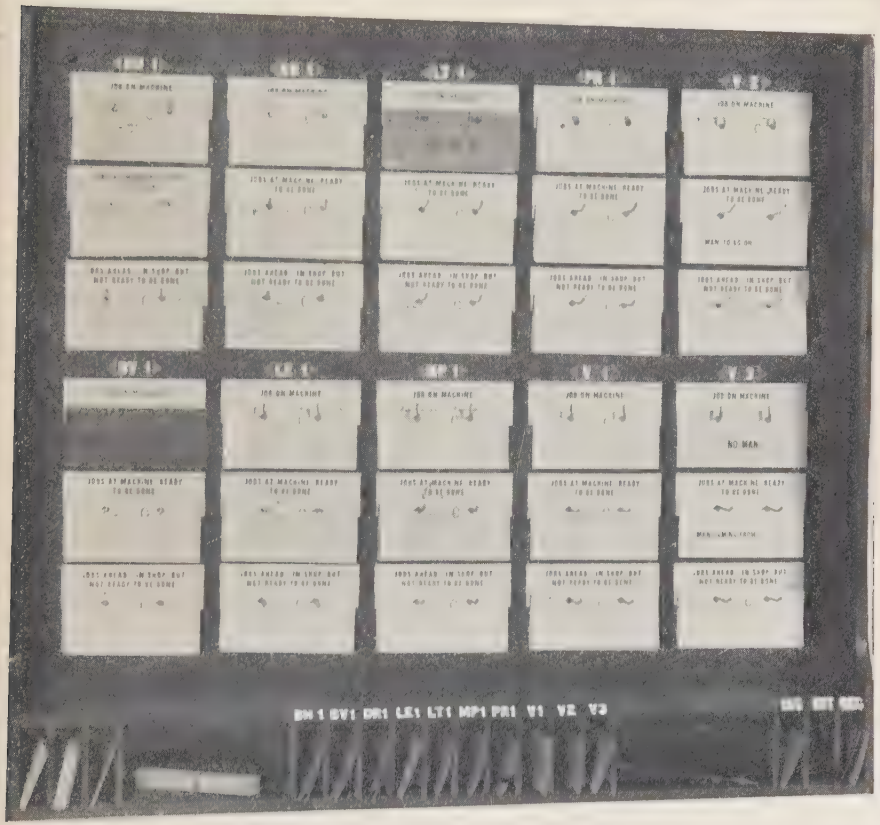

JOB ON MACHINE
JOBS AT MACHINE READY TO BE DONE
JOBS AHEAD IN SHOP BUT NOT READY TO BE DONE
NO MAN
BN 1 BV1 DR1 LE1 LT1 MP1 PR1 V1 V2 V3

Fig. 93.—Planning Department Bulletin Board.

position of work in the shop with respect to that particular machine or workplace. These hooks will be referred to hereafter as the first, second, and third hooks, and represent work in the following conditions as regards the machine or workplace. The first hook represents work which is on the machine. The second hook represents work at the machine ready to be done. The third hook represents jobs ahead in the shop and tentatively assigned to the machine or workplace, but not yet ready to be done.

The lower portion of the board consists of a number of small compartments, one for each of the work stations shown on the board, and other

compartments for miscellaneous uses. The compartments in the center of the board correspond to the machines or work stations which the board controls, and are utilized for filing tickets, relating to work assigned to the particular machine, in the manner hereafter described. The three compartments to the right are used for temporary filing of tickets that control the issuance of tools, drawings, and instructions, as will also be described. The other compartments may be used for miscellaneous purposes.

In each department of the shop there will also be found a shop bulletin board which will portray information concerning work for each machine or workplace in that particular shop. This shop bulletin board may be looked upon as a replica of that section of the central bulletin board which dealt with that particular department. It is set up in the department for the purpose of more readily correlating the activities of the shop foreman and the central planning department, and does not imply, in any way, decentralized planning. The method of arranging tickets on this board will be spoken of later.

Indicating the order of work. The order-of-work man is constantly working toward the master schedule. He will determine from this the time at which it will be necessary to place an order or a component of an order into production. He must consult the route sheets pertaining to the order for the path to be followed through the shop. In operating the order of work, he must constantly consult the route sheets, since any determination of when an operation is to be performed must rest largely upon the availability of the machines or workmen involved. When an order is to be started, he must first consult the route sheets to ascertain whether material is available. He will determine this by consulting the checkmarks which have been placed on the route sheet opposite the heading, " Material apportioned and on hand " (Fig. 85). In case he is dealing with an assembly operation he will consult the assembly route sheet (Fig. 86), and there ascertain whether the necessary material has been checked, " O.K." All such checks will have been made by the balance-of-stores clerk, who since he controls stores, will have been in a position to place this necessary information on the route sheets. If material is available, the order or component may be placed in production.

To place an order into production involves taking certain of the despatching tickets, which were prepared at the time the order was routed, from the files, and starting them through the routines which they affect. These will include stores issues, identification tags and move tickets. The stores issue forms were partially considered when the operation of the storeroom was considered. (Figs. 80, 81.) They were prepared from the route sheets, and filed after they had first passed through the hands of

the balance-of-stores clerk. The latter at that time utilized the information upon them to increase the apportioned column of the proper balance sheets, to correspondingly decrease the available column, and to take such other steps as might have been made necessary, as, for instance, to order materials. When the order-of-work man removes the stores issues from their file, they again pass through the hands of the balance-of-stores clerk. This enables him to write off the material which is being issued from the "On Hand" and "Applied on Orders" columns. The task of forwarding stores issues to the storeroom is a function of despatching. Usually, it is only necessary for the order-of-work clerk to place the issues in a designated place, which will indicate to the despatcher that these slips are to be forwarded to the storeroom and the corresponding orders thereby placed into production.

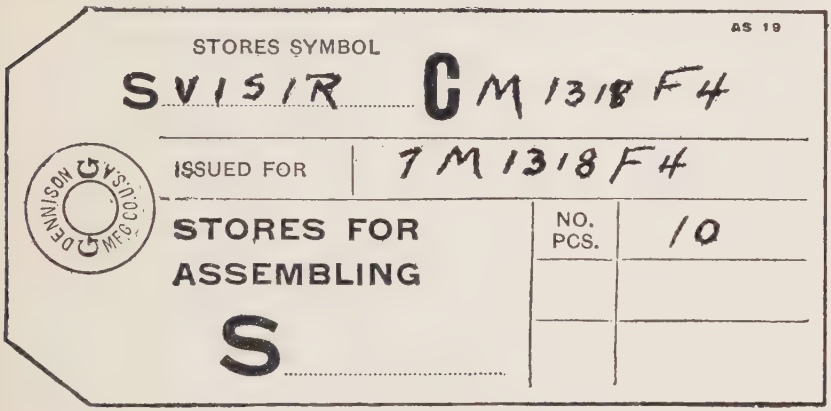


Fig. 94.—Identification Tag.

At the same time that the despatcher sends a stores issue to the storeroom, he sends along with it the necessary number of stores identification tags, which have already been prepared and filed (Fig. 94). These tags are attached to all stores issued and stay with the materials throughout the production process, thus clearly identifying them with the production order on which they are being used. The move ticket (Fig. 95) is now sent by the despatcher to those in charge of interior shop transportation, as authority to move the material in question from the storeroom to the department and production center where the first operation is to be performed. If the route sheet indicates alternate machines on which a given operation may be done, the writing of the move ticket is at times left to the despatcher, and he will select the machine by consulting the planning board as to availability. Identification tags and move tickets are often profitably combined on one form in a manner later explained.

The set of check columns on the route sheets used for recording the performance of designated operations now comes into play. The columns are headed "move," "operation," "first inspection" and "final inspection."[1] A check is made by the despatching clerk when he orders the performance of any of these functions on any operation indicated as necessary by the route sheet. For instance, when he issues the move

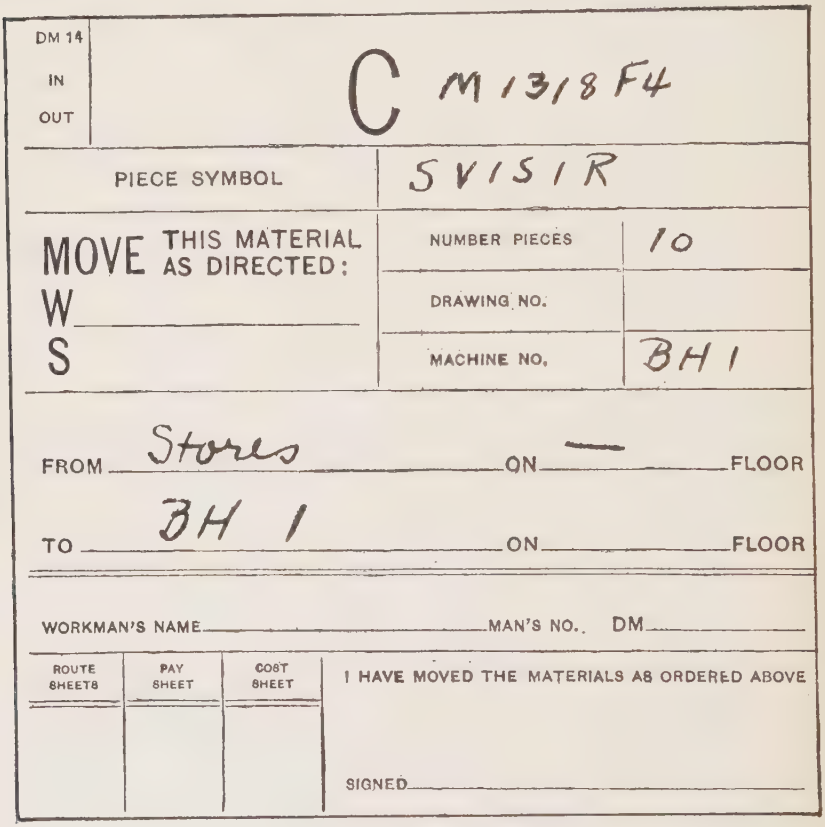

DM 14
IN
OUT
C M 1318 F4
PIECE SYMBOL
5 V 1 5 1 R
MOVE THIS MATERIAL AS DIRECTED:
W
S
NUMBER PIECES 10
DRAWING NO.
MACHINE NO. BH 1
FROM Stores ON — FLOOR
TO BH 1 ON FLOOR
WORKMAN'S NAME MAN'S NO. DM
ROUTE SHEETS
PAY SHEET
COST SHEET
I HAVE MOVED THE MATERIALS AS ORDERED ABOVE
SIGNED

Fig. 95.—Move Ticket.

ticket and orders the materials from stores to the first operation, he draws a vertical line halfway down the small space under "move" and opposite the first operation, thus indicating that he has ordered this action. When the move has been completed, those in charge of shop transportation return the move ticket to the planning department, noting upon it that the move has been made. This information is then posted by the despatching clerk to the route sheet by completing the vertical check under move

[1] See route sheets (Figs. 85 and 86).

and opposite the first operation. Anyone who might consult the route sheet would, therefore, become immediately informed as to the status of that particular order at that time, namely, that the material is at the machine ready for the first operation, but that this operation has not yet been performed.

Immediately upon receipt of information in the planning department that material has been moved to a production center, the scheduling

	DM 15 OPERATION ORDER C M 1318 F 4			
	OPERATION SYMBOL	7MF		
	TO EARN BONUS, WORK MUST BE DONE IN	2.48	NO. PCS.	10
	AMOUNT OF BONUS		DRAW. NO.	53748
IN OUT	WANTED FOR		MACH. NO.	BH 1
	HOLD FOR			

Fig. 96.—Operation Ticket. Planning department bulletin-board copy (white), shop bulletin-board copy (manila).

DRAWING AND INSTRUCTION CARD ISSUE	DM 3 OPERATION ORDER C M 1318 F 4			
OPERATION SYMBOL		7 MF		
NUMBER OF INSTRUCTION CARDS		1	NO PCS.	10
NUMBER OF TOOL LISTS		1	DRAW. NO.	53748
ISSUED BY SIGNED	RECALLED BY SIGNED		MACH. NO.	BH 1

Fig. 97.—Operation Ticket. Drawing, tool, and instruction card issue copy (pink).

function with respect to indicating the order of work again becomes important. At the time that the order was routed, there were placed on the third hooks of each machine or workplace affected by the order, triplicate copies of an operation ticket (Figs. 96 and 97). This ticket describes and controls the operation to be done on that machine in connection with that order. The tickets hanging on the third hooks will at any time clearly indicate the balance of work ahead of each machine or

department not yet placed into production. If alternate routing to a group of machines is provided by the route sheet, the operation tickets will usually be hung on the third hooks of one machine of the group previously designated. When material is moved to a production center, the order-of-work man must remove the proper triplicate set of operation tickets from the third hook and place two of these in proper sequence on

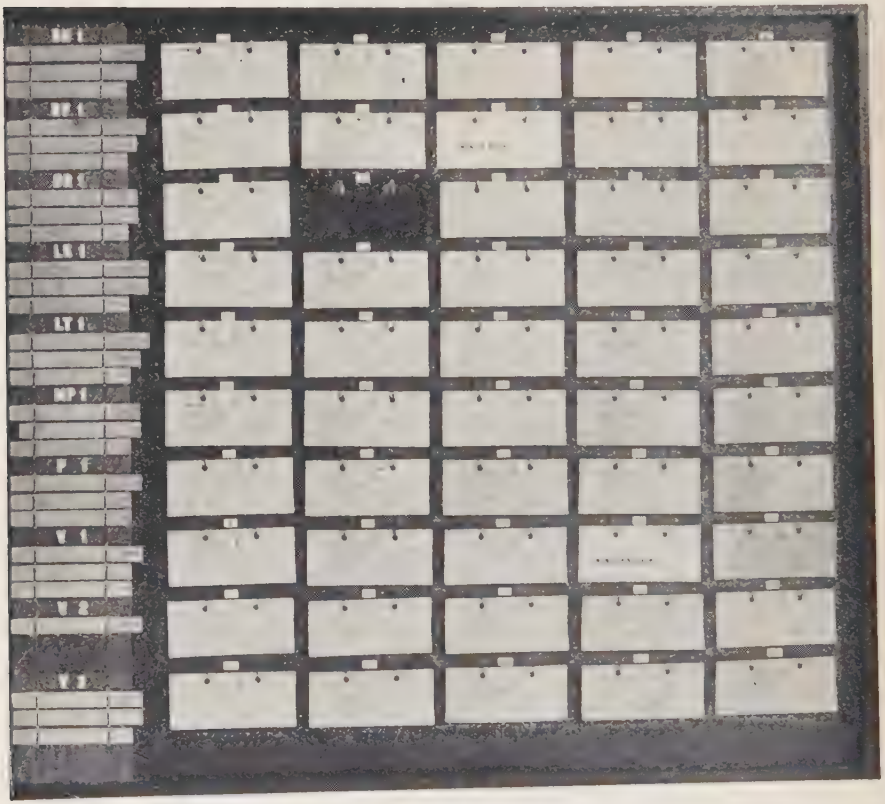


Fig. 98.—Shop Bulletin Board.

the second hook. The position in which he places them on the second hook will determine the order of work for that operation on that machine with reference to other operations already scheduled for the machine. He will determine the position based on the needs of the master schedule. The two copies that are placed on the second hook are the planning department bulletin board copy (Fig. 96) which will primarily control sequence (white in color) and the drawing, tool, and instruction card issue copy (pink in color) (Fig. 97). At the same time that these two copies of the

operation order are placed upon the second hook, the manila or shop bulletin board copy is taken to the shop board and placed there.

The shop bulletin board illustrated in Fig. 98, consists of two sections; on the right a series of pairs of hooks serially numbered; on the left a series of clips under headings for each machine or work station in the shop. When the shop copy of the operation order is placed on the shop bulletin board, it may be hung on any one of the serially numbered pairs of hooks

FIG. 99.—Shop Foreman's Bulletin Board, Universal Winding Co., Providence, R. I.

which may at the time be vacant. At the same time that this operation order is placed on this pair of hooks, there is placed under the machine heading a strip of cardboard on which is found a number corresponding to the serial number of the hooks on which the operation order is hung. The relative position of this strip of cardboard to other similar strips under a machine heading indicates the order of work for that particular machine, and corresponds exactly to the order of work as found on the second hooks of the planning department board. Another form of shop board, used at the Universal Winding Company, as illustrated in Fig. 99, provides for the placing of operation orders in sequence directly under the

machine numbers. Either method gives the necessary flexibility of operation.

Conditions of a particular shop will determine the number of operations for which material should be on hand at any production center, and also the number of these for which tools, drawings, and instruction cards should be on hand. The same tools may readily be used on more than one operation, and it is, therefore, not wise to have too many waiting at the production points. The pink operation ticket controls the issuance of the tools, as well as the drawings and instruction cards; and on shop conditions, and on the number of jobs ahead of a machine will depend largely the handling of this ticket. It may not be placed upon the second hook at all, but may be used immediately to order the tools, drawings, and instruction cards to the shop. Or, if there are a number of operation tickets on the second hooks, it may be placed on the second hook with the white operation ticket, as already indicated until it is the second or third job ahead. In any case when it is desired that the tools, drawings, and instruction cards be issued, the pink operation ticket is placed in the small compartment in the lower right-hand portion of the planning board marked " ISS " or issue. These tickets are periodically collected by a messenger, who, consulting them, takes the proper instruction cards and tool lists from the files and any necessary drawings from the drawing cabinet to the work station. The tool lists are subsequently forwarded with the requisite number of tool checks by the foreman to the tool room, as a requisition for the necessary tools for the operation. This procedure insures the utilization of standard tools for the operation. The pink ticket is then filed in the central section of the bulletin board under the machine number, thus indicating that the instruction cards, drawings, and tools are at the machine and the operation is thus ready to be performed.

Despatching to the workman. Let it be assumed that a workman has just completed an operation on a machine. He brings to the despatch window of the planning department the time ticket (Fig. 100) which had been issued to him at that same window at the beginning of the operation, and turns it in. This time ticket is stamped with the time of receipt and the workman is ready to receive a new time ticket for his next job. The despatcher consults the bulletin board and ascertains which job is next on the order of work on the second hook of that machine. He places this operation ticket on the first hook after removing the operation ticket for the job just completed. He then proceeds to the route file, removes the time ticket and inspection ticket (Fig. 101) for the new operation, hands the time card to the workman and forwards the inspection ticket to the inspector. At the time that the despatching clerk hands the time ticket to the workman, he draws on the route sheet a half check line under the headings " operation " and " first inspection " for that particular

task. At the time that the workman brings back his time ticket, indicating that the work has been completed, the despatcher completes this check line. After the inspector makes his first, or check, inspection, the inspection ticket is returned to the despatcher who completes the check line under first inspection.

DM 6
IN
OUT

C

FIRST TIME CARD
AND BONUS RECORD

M 18 24 4 J P 1

TOTAL WAGES $ | OPERATION SYMBOL 4 M J P

MACH. TIME	TIME ALLOWED	BONUS TIME	BONUS WAGES	No. PCS.	50
	3.25		$	DR. No.	56482

IF JOB IS NOT FINISHED SCRATCH OUT THIS F | IF JOB IS FINISHED SCRATCH OUT THIS NF | MACH. No. BH 1

DAY									TOTAL
PIECES FINISHED									
TIME UNITS									

WORKMAN'S NAME | MAN'S NO. DM

I HAVE CHECKED THESE ENTRIES AND BELIEVE THEM TO BE CORRECT:

HRS. X COST No. | SIGNED BY FOREMAN

ROUTE SHEETS	PAY SHEET	COST SHEET	BONUS EARNED / BONUS NOT EARNED	
			THE ABOVE WORK HAS BEEN INSPECTED AND FOUND O. K. DEFECTIVE	

Fig. 100.—Time Ticket.

Upon receipt of the time ticket from the worker at the completion of the operation, the inspection ticket is reissued to the inspector for recording of final report as to quality and number of the lot that is good and can be continued in process, and a half check line drawn under that column. Upon receipt of the final inspection report from the inspector, this line is completed. The time and inspection tickets are now forwarded to the rate-setting or cost department for addition of bonuses, deduction of penalties, and general payroll purposes, as well as for entry on the necessary cost records.

Upon the receipt of the final inspection ticket from the inspector, the pink operation order controlling the drawings and instruction cards is removed from the receptacle under the machine number at the bottom of the planning board, and is placed in the lower right-hand corner of the planning board under the heading "REC," signifying recall. This is a signal to the messenger to bring back all drawings, instruction cards, and tool lists from the machine or workplace to the planning department, where

DM 18
IN
OUT

C M 18 24 4 J P 1

FIRST INSPECTION	OPERATION SYMBOL	4 M J P
I HAVE INSPECTED THE WORK DONE ON FIRST PIECE AND FIND AS FOLLOWS:		No. PCS. 50
ROUTE SHEETS	MAN'S NO. DM	DR. No. 56482
	SIGNED BY INSPECTOR	MACH. No. BH 1

FINAL INSPECTION: I HAVE INSPECTED THE WORK DONE ON ABOVE OPERATION AND FIND AS FOLLOWS:	PIECES DELIVERED TO MACHINE	PIECES LOST AT MACHINE	PIECES DAMAGED EXTRA WORK

PIECES DAMAGED NO EXTRA WORK	PIECES SPOILED AT MACHINE SCRAPPED	PIECES DAMAGED STOCK	PIECES SPOILED STOCK	DEFECTIVE CASTINGS	PIECES O. K.

ROUTE SHEETS	BONUS RECORD	PAY SHEETS	MAN'S COST SHEET	PRODUCTION RECORD	SIGNED BY INSPECTOR

Fig. 101.—Inspection Ticket.

they are properly filed. It is a function of the foreman to see that tools are returned to the tool room at this time.

Upon the receipt of the final inspection ticket, there is issued the move ticket for the next operation as indicated by the route sheet, and a half check line is drawn under the move column for this operation. Upon the receipt of this move ticket, those in charge of shop transportation move the worked materials from the machine where the work has been com-

pleted to the machine or workplace where the next operation is to be performed. They then return the move ticket to the planning department, a full check line is drawn under the heading " move " for this operation, and all procedures as explained above for the first operation continue for the second and other succeeding operations in exactly the same manner.

If a job be interrupted and the operation postponed for any reason, the operation ticket is removed from the first hook and placed on the second hook, in conformity with the proper order of work. At the same time all drawings, instruction cards, and tool lists are recalled from the shop, if the delay is to be a long one. Such recall is accomplished through the removal of the pink operation ticket from under the machine number at the bottom of the planning board. This ticket is placed in the lower right-hand compartment headed " INT," signifying interruption. The messenger, observing the pink slip in this location, brings all papers from the shop and files them.

Control of shop conditions through the planning board. Shop conditions may be told at a glance by reference to the planning board if cards are provided, to be hung on that board, which will clearly give such information concerning each work station. For instance, there may be an operator's card, containing the operator's name and number, and a list of the machines or workplaces which he is qualified to operate or at which he is qualified to work. This card, hung on the first hook of the machine at which the man is working, gives the planning department an unusual ability to control men to best advantage, and particularly to suggest to the shop foreman changes of men between machines in cases of emergency. A card with the words " No Man " printed upon it may be hung under any machine where there is work to be done, but no operator available. A " Man Not In " card may be used to indicate that an operator is absent. A " Machine under Repair " card may be used to indicate that a machine is shut down for repairs. " Man to go on —— " and " Man coming from ——" cards may be used to show the planned transfer of workers from one workplace to another after a current operation is finished. These cards are usually in distinctive colors which will enable members of the planning department to quickly visualize shop conditions. Some plants, in place of certain of these cards, prefer a " Machine Inactivity Card," such as illustrated in Fig. 102, on which the relevant information may be checked. This card may be time-stamped and forwarded to the cost department for computation and distribution of idle time costs.

Description of important forms used in despatching. The time ticket serves more purposes than any other form used in despatching. It informs the worker of his rate (if this is not on the instruction card). It records the length of time consumed in the operation, and is, therefore, a basis for all cost computation, and wage payment, and it is a vital link in the

despatching system. The amount of information which must be placed upon it, therefore, is great, particularly compared to a ticket, such as the operation ticket, which is used only for control. Duplicate copies of time tickets may well be used to replace operation tickets, unless it be felt that the larger amount of information on the time ticket may lead to confusion, or to using too much space on the planning boards. Figure 100 is an example of a time ticket which will indicate the basic information

Ret. Iss'd		Machine_____ Location

MACHINE INACTIVITY CARD

Check Reason for the Inactivity of the Machine with Cross (X) in the Column to the Left of the List Below.

	Lack of Man
	Lack of Material
	Lack of Work Assigned
	Lack of Supplies
	Machine Under Repairs

Signed_____

Remarks_____	Machine Time	Hourly Machine Rate	Inactivity Cost

Fig. 102.—Machine Inactivity Card.

which is necessary on such forms. The order which is to be charged with the labor represented by the ticket must be indicated, as well as the operation number, which will make possible allocation of costs to operations or departments. Provision must be made to indicate when the ticket is issued and returned. The time when the job is completed is stamped above the time when it is begun to permit of easy subtraction of elapsed time. Best practice dictates the use of decimal clocks, which record hours and tenths of hours, rather than hours of the day. On such a clock the

time that the plant starts, say 7 A.M., is 0 hour, 7:30 is 0.5, 8 A.M. is 1, and 8.45 is 1.75. This makes elapsed time computation extremely simple. In some plants where jobs are long and run over several days, the clocks are so set and controlled as to count elapsed hours for the week. Thus, on an eight-hour day, Wednesday morning 9:30 A.M. would be stamped as 18.5. If an incentive wage system be used, it is desirable to indicate standard time, the base rate, and the bonus earned on the time ticket. At the bottom of the ticket there are check spaces headed " Route Sheet," " Pay Sheet," and " Cost Sheet," to provide for checking proper posting of the time ticket.

One of the more recent developments in time tickets provides for the use of tabulating machine cards, as illustrated by Fig. 103. All of the

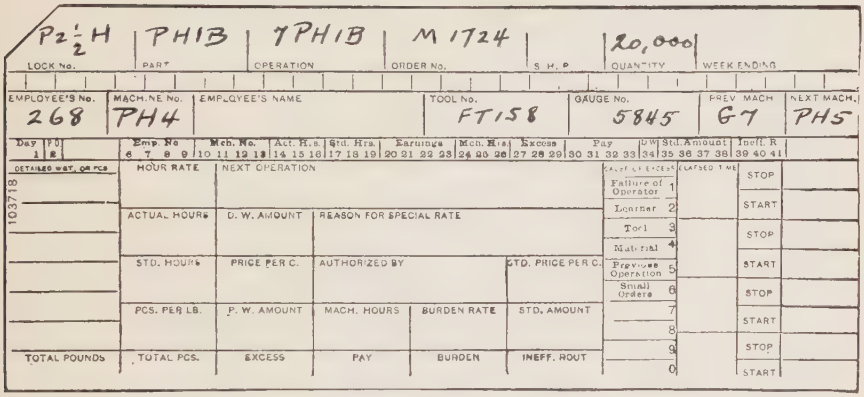


FIG. 103.—Time Ticket for Use in Tabulating Machine.

necessary information can be written on the card, and then when full use has been made of this, the card can be punched, on the basis of this information, for use in the tabulating machine. The cards then can be run through the tabulating machines and information concerning general shop conditions, conditions of work, or wage payment quickly secured. Some plants are using carbon copies of tabulating-machine time cards for control of operations in the usual way.

In any shop there will be a certain percentage of imperfect work done or material spoiled. Some of this spoilage will have a distinct effect on the order of work and despatching, inasmuch as the spoiled work has been relied upon to meet other work at certain stages of the process. The planning department may secure the necessary information in this connection from the inspector, on the inspection ticket, or on a special damage report, such as illustrated in Fig. 104.

The most important part of almost any form used in control is the check spaces provided for insuring the performance of all functions that

REPORT OF IMPERFECT WORK OR DAMAGE DONE.

MACHINE SHOP _____

MR. _____

MONTH	DAY	YEAR
		19

ORDER No. _____ MACHINE No. _____

No. OF PIECES _____ SYMBOL _____

DRAWING No. _____

DAMAGE DONE _____

MAN WHO DID DAMAGE TO WORK OR MACHINE _____

GANG BOSS OR FOREMAN IN CHARGE _____

REPORTED BY _____

PASSED OR CONDEMNED _____ BY _____

COMPANY'S LOSS _____

PRICE PAID FOR WORK _____

PRICE TO BE PAID FOR REPAIRING DAMAGE _____

TIME REC'D _____

SIGNED _____ SIGNED _____

REMARKS _____

PROD. CLERK		APPROVED MANAGER		DRAWINGS PREPARED		ROUTING		FOUNDRY Tags Written		MATERIAL Apportioned		TAGS, ORDERS, etc. WRITTEN		BUYER	
DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR

INSTRUCTION CARDS				ROUTE FILE PREPARED		MAN'S RECORD		TOOL ROOM				STORE ROOM		PATT. SHOP	
TIME STUDY		SLIDE RULE						ORDERS WRITTEN		INVENTORY					
DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR	DAY	HOUR

FIG. 104.—Damage Report.

deal with the information covered by the form. Manufacturing orders, time tickets, damage reports, and other forms which are the basis for a procedure involving two or more persons may all well have these check spaces provided. They not only permit quick placing of responsibility for errors made, but also prevent errors and oversight, and insure that once a procedure is started, all necessary steps in connection with it will be taken.

Minor modifications of this typical procedure. If any advantage is to be gained from these pages on order-of-work and despatching procedure, it is essential that the form be not misunderstood for the essence. They form a ready basis for adaptation and simplification. They clearly indicate a unified method of controlling all of the factors of production which must be currently controlled while an order is in process. Some of the methods of adaptation to particular conditions will next be considered. Meanwhile it is desirable to point out that the devices which are used in this system may be changed without in any way affecting the factors controlled or the method of control. For instance, some plants, instead of the planning board, with hooks, utilize pockets or boxes for distribution of the tickets controlling operations. An illustration of this is found in the picture of a portion of the planning department at the Universal Winding Company (Fig. 87). Many plants utilize a two-hook planning board rather than the three-hook type which has been described. In such cases, jobs are not posted until an operation is ready to be performed, and the operation tickets are retained in file until that time. The balance of work which is secured from the third hook is here secured by some sort of a chart, such as a load chart, which will clearly indicate conditions of departments and machines.

CHAPTER XLII

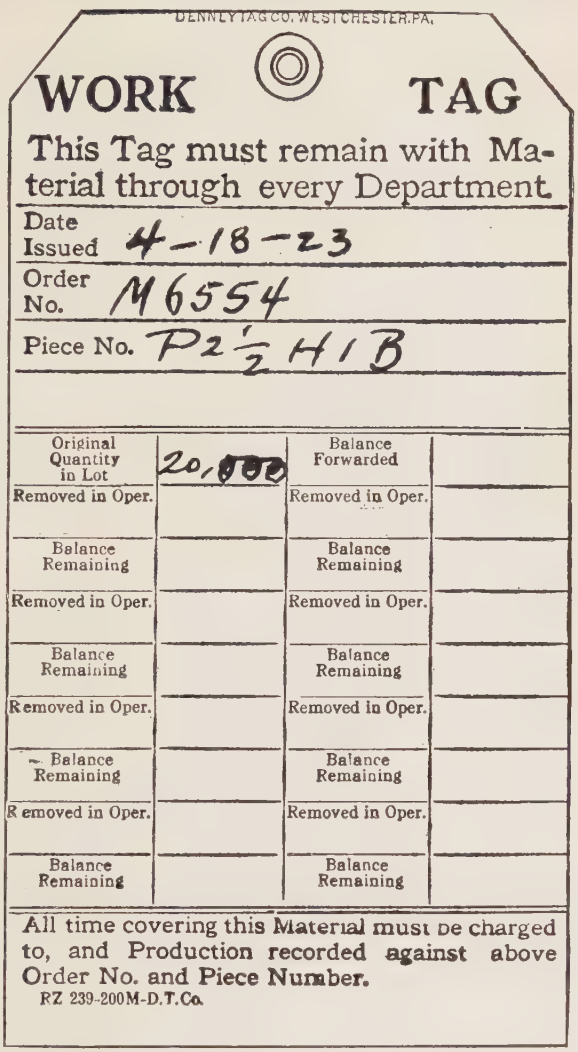
ADAPTATION OF PRODUCTION-PLANNING METHODS

Although successful production planning necessitates an infinite attention to detail, as may well be imagined from what has just been covered, strangely, more attempts at careful production planning have been wrecked in the attempt to reach 100 per cent perfection than for all other causes together. Since the purpose of production planning is to control operations in such a way that they will be performed on time and at lowest cost, care must always be exercised that planning schemes do not slow up production. If the planning system be so arranged that much time is taken by the workman in the exchange of job cards, or if there must be provided an inordinately large clerical force to handle the planning procedure, the difficulty probably is that the planning has been attempted on too exact a basis, and that in the attempt to reach exactness, costs have been increased. 98 per cent perfect planning is likely to prove more profitable than planning which reaches 100 per cent perfection. Thus, in routing work, alternate machines may well be indicated, though it will prove profitable to call attention to the excess costs of production on the alternate machine. In developing an order of work, if 100 per cent perfection be the goal, it is probable that alternate provisions for work for a machine will not be made, on the assumption that the work which has been planned ahead will always be ready. If 98 per cent perfection be set as the goal, the planning department will be likely to have made some general arrangements to take care of the hold-ups which will inevitably occur, and therefore, in the long run, the control of production operations will be smoother. If the importance of flexibility be considered along with the desire to secure 100 per cent control, then it may be that great success from the efforts expended will be secured, but this will in reality only mean about 98 per cent control, because supervisors foremen, or other executives under such conditions, will be left with some measure of discretion.

Adaptation of the centralized planning procedure. It was mentioned that the system of centralized order of work and despatching which has been described is an excellent one to consider, because of the clear separation, under it, of the control of each of the various factors of production. Some of the more frequent forms which adaptation of this

procedure take involve combination control over several of these factors, or the issuance of the control orders in a somewhat less formal way that often tends to speed up production.

Combination identification tag and move ticket. Inasmuch as the route which materials are to take is, in general, determined before the materials leave the storeroom, one of the first moves in changing the described procedure is usually the elimination of the move ticket. The identification tag may be somewhat enlarged and on the back may be placed the route through the plant. As one operation is completed the move may be ordered by the inspector who has passed the materials, or if there is no inspection needed at that point in the process, as is often the case, the move man may receive orders to move from the shop foreman. In such cases the movement of the material is reported to the planning department at the same time that the inspection report or the job ticket is handed to them. They have continual knowledge of the location of the material, but they order the movement from each operation at the time that they first order the goods from the storeroom. This considerably speeds up production, and is very successful when the


DENNEY TAG CO. WESTCHESTER, PA.

WORK TAG

This Tag must remain with Material through every Department.

Date Issued 4-18-23

Order No. M6554

Piece No. P2½HIB

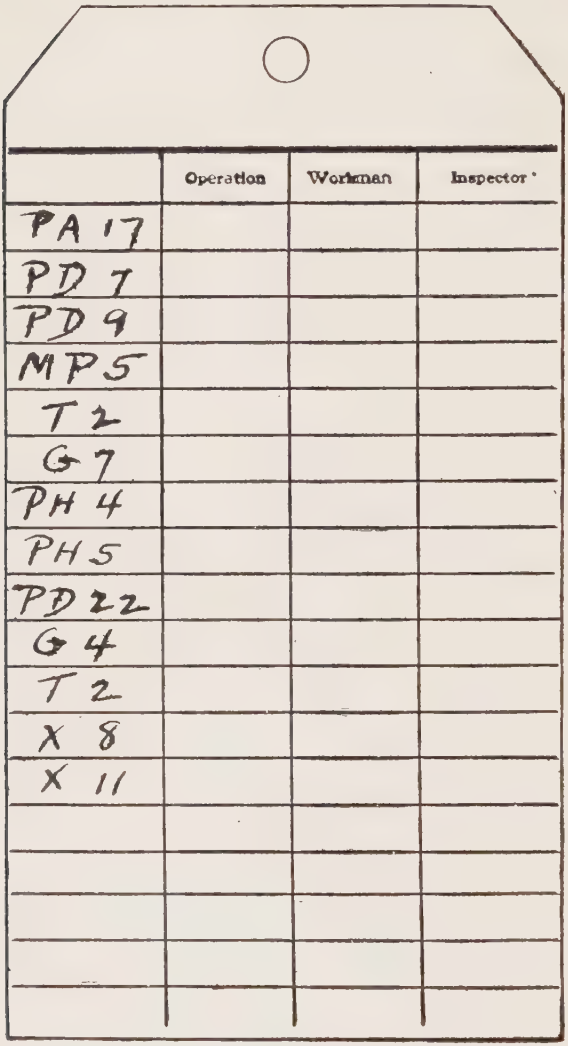
Original Quantity in Lot	20,000	Balance Forwarded	
Removed in Oper.		Removed in Oper.	
Balance Remaining		Balance Remaining	
Removed in Oper.		Removed in Oper.	
Balance Remaining		Balance Remaining	
Removed in Oper.		Removed in Oper.	
Balance Remaining		Balance Remaining	
Removed in Oper.		Removed in Oper.	
Balance Remaining		Balance Remaining	

All time covering this Material must be charged to, and Production recorded against above Order No. and Piece Number.

RZ 239-200M-D.T.Co.

FIG. 105.—Combination Identification Tag and Move Ticket (Front).

route is not subject to constant changes. If minor changes need to be made, these can easily be made on the identification tag when the goods are in process, by a representative of the planning department. Such a tag is illustrated in Figs. 105 and 106.



	Operation	Workman	Inspector
PA 17			
PD 7			
PD 9			
MP 5			
T 2			
G 7			
PH 4			
PH 5			
PD 22			
G 4			
T 2			
X 8			
X 11			

FIG. 106.—Combination Identification Tag and Move Ticket (Back).

Combination time, inspection, and move ticket. Some plants have retained the identification tag in its original form but have combined the move ticket with the time ticket. Possibly the inspection ticket is replaced by space on this same form (Fig. 107). Thus, when a time ticket is issued to a worker, there is noted on the bottom of the ticket the next operation and where it is to be performed. When the operation has been performed, the foreman directs the move man to take the materials to the location specified, and reports this action upon the form. Prior to such movement, the inspector will have inspected the operation and will make his report on the same ticket. Thus the planning department need only order performance of an operation, and inspection and movement follow automatically. This gives the foreman somewhat more direction of the production process, but is not really important from that angle. It reduces the number of forms which have to be handled, and in most cases

does not materially lessen the amount of planning department control. Proper modifications must be made in such cases in the checking of progress on the route sheet and the issuance of new job cards to the worker. Time ordinarily must be stamped on the time cards by the foreman or his representative in the shop, and issuance of new job cards must be on the request of the foreman, as he sees that the worker is nearing the end of the

RETURNED ISSUED				CHARGE TO M 1318 F 4			
AP 34							
OPERATION NUMBER 7 MF		KIND OF OPERATION Assembly					
A=PREMIUM LIMIT HOURS	2.48	MAN'S RATE	MAN'S TIME		TOTAL EARNINGS	MACH. NO.	LOCATION
B=TOTAL HOURS TAKEN							
I HAVE INSPECTED THE ABOVE MATERIALS AND FIND THEM							
			SIGNED BY INSPECTOR				
MOVE ABOVE MATERIALS From BH 1				To LE 3			
NO. OF PIECES MOVED			RECEIVED BY				

FIG. 107.—Combination Time, Inspection, and Move Ticket.

job. This change is made necessary by the retention of the time ticket in the shop until after final inspection of the operation.

Location of despatch stations in the shop. In plants of any size where central planning is retained, it is desirable to locate despatch stations in the shop, or to provide pneumatic tubes through which time tickets may be transmitted. Because of the expense of the latter and the desirability of direct contact between the workman and the man who is handing him his job, the first alternative is usually adopted. At times despatch stations in the shop are even provided when there are despatch tubes, in

order to gain the advantage of personal contact. If the worker comes to feel that there is some unseen hand telling him what to do, he is likely to complain much more readily than if he has the opportunity to see and know intimately the man who is handing out his work, even if the latter has no great authority. Some have felt that this leads to unnecessary conversations, and hence loss of time, but if it does, it is usually time well lost. Despatch stations in the shop do not imply decentralized control. They merely issue the tickets which they are told to issue by the central planning department. Perhaps they have some control over movement of material. At any rate, in large plants, they save steps and time for the worker. To have the worker come to the window of the planning department for his new time ticket is only possible in small plants.

Strip operation tickets. Where the sequence of operations is practically standardized, regardless of the particular style of product being manufactured, as in a shoe or a hosiery plant, it becomes profitable to control operations in groups through the use of strip operation tickets. Such a ticket is illustrated in Fig. 108. This ticket is assigned a number and attached to the batch of materials as it is about to start through a series of operations. It has a coupon for each operation in the series. As the worker performs an operation, he detaches a coupon, part of which he usually gives to his supervisor for transmission to the planning department, and part of which he retains for purposes of checking with his pay envelope. This portion of the coupon for the worker is made necessary as there is no direct check with him to insure that he has received credit for the work that he has done. He only receives such credit as a batch of tickets is turned into the planning department. Where operations are short and must be performed in the same sequence, this gives all the necessary control for the planning department and at the same time allows the goods to flow through the factory promptly.

A number of different strip tickets can be provided for the whole sequence of operations, each ticket covering a controllable unit. The order of work can be maintained throughout the sequence of operations covered by one ticket, if the numbers on the tickets correspond with the order of work, and if the batch or lot of goods with the lowest serial number is put through each operation first. Manifestly, serial numbers can be changed at the end of each series of operations. Movement of material at the end of a series of operations must be on separate order from the planning department, as in the case of any other system. Where inspection is necessary after operations, it is usually treated as one of the operations covered by the strip ticket.

Operation of decentralized planning control. Decentralized planning control always is a necessity in very large plants, and where entirely different types of businesses are carried on within one building, as in the

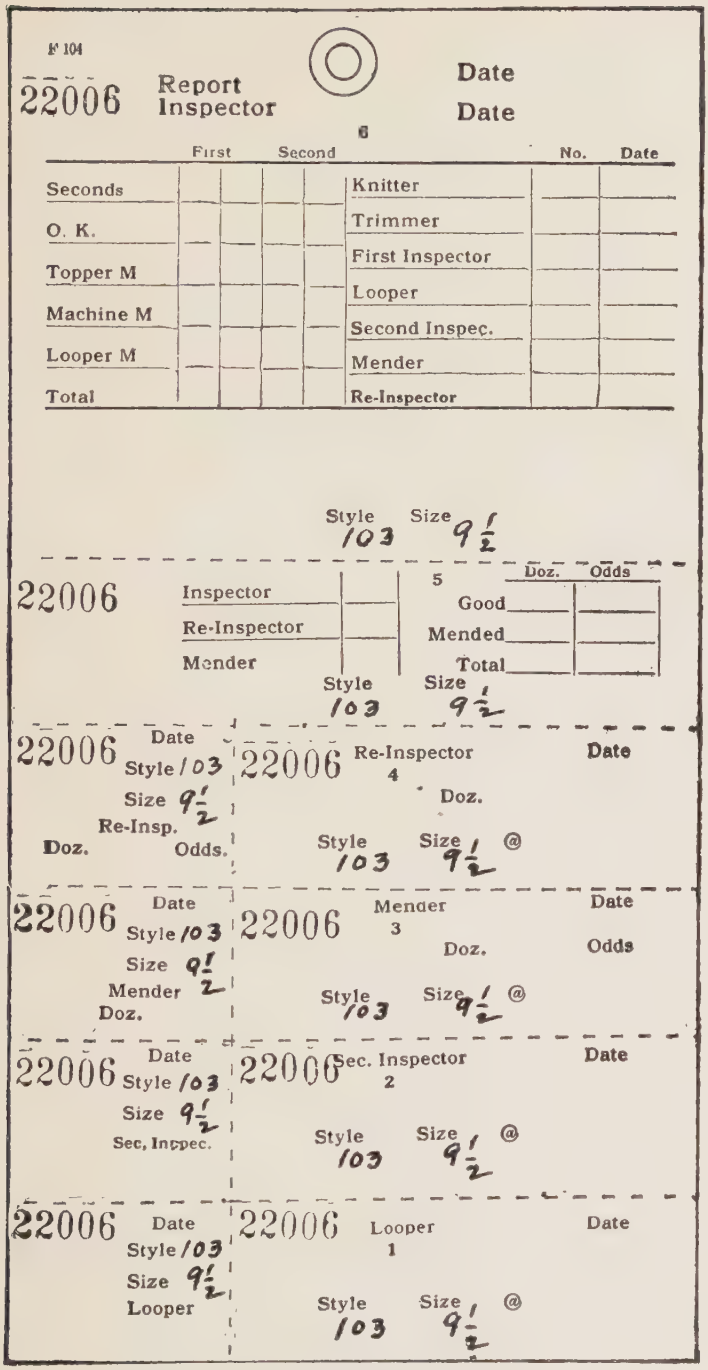


FIG. 108.—Strip Operation Ticket.

case of the manufacture of stationery and the boxes in which the stationery is sold. Decentralized control is frequently set up when it is the desire of the management to allow the foremen to maintain a considerable share of the task of planning work. It has already been indicated that the development of the master schedule and routing between departments are functions which must be performed centrally. Portions of the other planning functions may be decentralized.

Routing to machines is the planning function which is most frequently left to the department planning supervisor. If this function be given to him, of necessity much of the operation of the order of work will automatically go with it. If there be decentralized control, despatching to the worker will always be done within the department. If routing is to be given to the shop planning supervisor, whether he is or is not under the control of the foreman, there are usually certain operations which must be routed centrally. These are the key operations, or operations which may only be done on one or two machines. This is necessary to prevent throwing the shop out of balance.

If there are departments which have large batteries of the same kind of machines, all capable of doing essentially the same kind of work, ideal conditions for decentralized routing are found, because the foreman or the shop planning supervisor will ordinarily be in a much better position to determine the machine to which a particular job should go than would be the central planning department. In such cases, the routing of material to the department, always a function centrally performed, is in reality routing to a particular group of machines. The decentrally controlled routing takes on the nature of a despatching function, which will indicate the machine of the group, which, from the standpoint of shop conditions, is best able to take on the particular operation. If routing of this nature be done decentrally, the central route sheets will ordinarily only indicate departments, not machines, while there will be no necessity of maintaining route sheets within the department.

The planning station in a department of a shop operating under decentralized control may well maintain a planning board which is similar in almost every respect, including operation, to the central planning board already described, except that it will cover only the machines and workplaces of the one department. If such boards are maintained departmentally, then there will be no need for the central board. This will be replaced by some sort of progress chart which will indicate the operations to be performed, by departments, and the progress that has been made upon them. Progress charts of this kind have already been described.

Under decentralized control, movement of materials between departments may well be ordered by the departmental planning unit, but after consultation, usually by telephone, with the central planning force.

However, each departmental unit will ordinarily have a move man under its control. Movement of material from stores to the first department in which work is to be performed will usually be ordered by the central department. If work be moved from a production department to a separate inspection cage, under decentralized control, the department planning unit will usually order the work into the inspection cage, while the ordering of the work out of the inspection cage to the next department will frequently be left to the central planning group.

There are no new planning concepts involved in decentralized control. It is only a means of making the control run more smoothly under the conditions which have been mentioned. Nominally, the foreman is usually put in charge of the departmental planning under this arrangement. Nevertheless, the planning clerk in the department, who is nominally supposed to report to the foreman, is usually given such complete control of planning by him that he is, to all purposes, wholly a representative of the central planning department in the shop. Besides correlating the work of the department with the central plans, he will make reports of progress on work under way, which will enable the central department to post any records of progress which they may maintain. In any case, he is a force working toward flexibility in planning.

CHAPTER XLIII

MANAGEMENT CONTROL THROUGH COSTS

The yardstick by which operating effectiveness must be measured is the cost of performance. To this end the science of cost accounting has striven, and has provided data which may be utilized as a large portion of the basis of operations. Business tragedies which have resulted from attempting to operate without a developed cost system have demonstrated the necessity of cost collection and analysis to the complete satisfaction of the manufacturing community. Cost accounting has developed as the companion science of management and as the staff on which management must lean for many of its most important decisions. The highly developed technique of cost accounting cannot be here given adequate attention. Means of cost collection have been indicated, but the technique of analysis of costs and their relation to the general books of the company are important accounting problems which must be considered separately and at great length. Such consideration must be left to texts on cost accounting. It is with costs as an instrument of service to the manager that we are concerned, costs as a means of reaching operating decisions, and as a guide in control.

Though cost accounting forms the soundest groundwork for information on which management decisions may be based, and profits insured, like other business methods, it is not an aim in itself. It is only of value in so far as it aids in operations and in the making of intelligent executive decisions which will promote the healthy advancement of the business. And no cost system, however elaborate, can itself insure these decisions or this advancement. Cost reports, regardless of their value, are inanimate and cannot themselves make betterments or insure intelligent operation. They must be studied by the executives and translated into the action toward which they point. They give the information for control, but they cannot themselves do the controlling. This point of view is important, for all too frequently an elaborate cost system has been set up without the means being provided for following up the reports which result. And sometimes the elaborateness of the system itself has defeated its own ends, because final cost reports have been submitted at such a late date as to be useless as a basis for action. Cost reports must be on current periods if they are to serve for management control, in order that action may be

immediate and in order that the business ship may be steered around the reefs which the reports have indicated to be immediately ahead. Post-mortem cost information may tell why some business catastrophe happened, but it will never prevent its occurrence.

In order to serve as the basis for management control it is essential that the cost system be developed with a view to its utilization primarily for that purpose. In order that management control may be sound and the business be guided into safe channels, there are some fundamental thoughts concerning the utilization of costs for guiding operations which must be thoroughly understood. This final chapter will indicate the most essential phases of these relationships.

The cost system as related to the organization of the plant. Regardless of the construction of the cost accounting system it must be such that individual and departmental responsibility may be closely checked. It may be that costs will be collected primarily on the basis of manufacturing orders, rather than departments. This will be wise in all cases of diverse production where customers must be quoted on orders, and will be useful under many other conditions. But provision must be made for the collection of information which will enable careful check-up of responsibilities which have been delegated. This information may well cover not only the routine responsibilities, such as departmental operation at lowest unit cost, but also special responsibilities, such as may be assigned in the preparation of a budget. If new functional departments are constructed, or if development programmes are undertaken, the cost system must allow computation of the savings effected through the changes. Otherwise these new departments or new work may have difficulty in establishing and holding the esteem of other branches of the business, particularly any which may have opposed the change prior to its consumation. Thus, if job-study work be developed, it will be most desirable to be able to balance the cost of the taking of the studies against the savings through lower unit costs on those operations which are studied. If a planning department be instituted, it should be possible to know the savings in direct and indirect labor in the factory departments which have resulted from the expenditures incident to the creation of the planning force. Such information becomes of particular value as planning work is extended, since it meets opposition successfully when the planning department has proved its value, and prevents hasty extension when conditions demand a higher degree of success with work already undertaken, rather than the taking on of new work.

The cost accounting department should be in a position to furnish valuable statistical information, or if there be a separate statistical department, to give this department the basic data from which the statistical information may be gathered. The personnel department should be able

to gain accurate information concerning the actual cost of replacement of workers. As has been seen, this is partially dependent on the lower productivity of new workers, and the amount of spoilage which can be attributed to having a "green" operator on the job. Such information can be secured most logically from the cost records. Although it may be taken off the production records by the planning department prior to the time that these are turned over to the cost department for costing, nevertheless this is primarily a cost problem. Such studies are only samples of the way in which cost information may be utilized to enable the organization, as constructed, to operate more smoothly. The personnel department will be able to determine the necessary care in selection for particular jobs, and to follow up the effectiveness of its own operation far more successfully, if it have such information at hand.

If modern management is to be most effectively developed, it is particularly important that no cost reports be rendered which will stress only the proportion of direct to indirect labor expenditures. Some cost systems seem to have been developed with this as one of the primary objects. Indirect labor is never unproductive if it returns in savings more than the added cost of its utilization. Inasmuch as there is a natural tendency, which is wise, to question indirect labor, it is essential that cost reports shall not handle indirect labor merely as an expenditure to be compared with direct labor charges. Thus the total of indirect labor charges need not be scrutinized half so carefully as the individual items, but these should be carefully analyzed, and compared with savings in a manner similar to that just indicated. The proper relation of direct and indirect labor expenditures varies of necessity from industry to industry and from one department to another. As labor-saving machinery is developed, the percentage of indirect labor to the total naturally rises. Improvement in management method operates in much the same way, and both improvements make comparison of these expenditures on the percentage basis wholly unwise.

In periods of depression when the pay-roll must be cut at all hazards, and regardless of ultimate cost, departmental analysis of costs which indicate savings effected under different operating conditions, as well as actual expenditures, make possible intelligent pruning of the pay-roll, rather than the hit-or-miss methods which are inevitable if analyzed data be not available.

Standard costs. As an aid to simplification of cost accounting procedure and the fixing of the selling prices for products, one of the more recent cost developments has been the setting of standard costs. That is, the normal expenditure for material, direct labor, and overhead charges for a given product, or for a number of hours production in a given department, is computed. This allows the elimination of much detailed cost

analysis, and at the same time permits adjustment at the end of a period through the totaling of actual departmental cost during a period and comparison with the normal or standard cost. If the actual cost of a given job performed during the period be wanted, this may be secured through applying the ratio for the period between normal and actual cost of all jobs to the particular job in question. Such a system is valuable because it permits the formulation of long-run production and sales policies which are not disturbed by minor fluctuations in operating conditions, and it furthermore makes possible the separation of normal production costs from costs which are due to the position in the business cycle or general efficiency or inefficiency in the management as a whole.

If an attempt be made to secure an absolutely accurate cost on each order, which cost shall currently absorb all overhead or indirect charges, a fluctuating cost necessarily results, which makes difficult the determination of long-run business policies. With a plan of standard costs, prices remain fairly constant, and losses or gains in operation are directly chargeable to the general businesses accounts which are responsible for them rather than to the departmental or order accounts which have had no responsibility whatever for the conditions as they exist. Thus volume of business comes to be figured in terms of hours of production and quantity of product, rather than in terms of dollars of business. This is a far more accurate estimate, because dollars of business is always likely to include a more or less constant fixed overhead burden.

Under many cost systems wherein overhead costs have been largely pro-rated as business is carried on, overhead costs have not been added in sufficient quantity when business was good, thus cutting down selling prices and prohibiting the establishment of a reserve for bad times. Similarly, they have been added to heavily in times of slight production, with the result that costs have increased as selling has become more difficult. Frequently, managers have realized the impracticability of spreading overhead over a greatly diminished product, and have charged a large share of it directly to the profit-and-loss account. They have less commonly kept their overhead up during times of prosperity, so as to create for themselves a reserve to which they may charge the unabsorbed overhead of times of depression.

Idleness expense. Standard costs have been developed with the idea of eliminating fluctuations from the selling price of products, in so far as this is practical. To secure full benefit from the utilization of this idea, a rather full study must be made of idleness expense, and this then becomes one of the primary objects of the cost system. The reports on costs of idleness give the general management much of the information with which to direct their general policies. If the plant be operating on part-time only, the cost of maintaining the portion of the plant which is idle must be

taken up either in the selling price of such articles as are manufactured, or must be charged directly to profits. There has been much thought of "absorbing" overhead, too much for the good of general managements. Of course, overhead expenditures must be taken care of, but if they are absorbed in the product being manufactured, the causes of idleness and of the increased unit overhead charges are not likely to be brought to the attention of those who are in a position to correct them. If these charges be directly listed under some such heading as idleness expense, they will force themselves to the attention of the chief executives for correction, and selling prices can be fixed to include some of this cost of idleness or to exclude it entirely, as may be deemed wise under the conditions which prevail. This will be determined largely by considering whether the product can be sold in competition if the expense be added on.

The system of planning which has been described is of inestimable value in securing information on which to develop idleness expense charges. The planning department is not only able to give to the cost department information concerning equipment which is idle, but is in a position to accurately determine the cause of the idleness. It only remains for the cost department to compute the cost of idleness and to render reports to the responsible executives. These may then take the necessary remediable action to attempt to cut down or eliminate the idleness which exists. A certain proportion of this will be found to be due to lack of sales, which may or may not be remediable. On the other hand, an intense analysis of the data will indicate the cost of ineffective operation of the purchasing or inventory control, of the maintenance department, of the planning department, or of the personnel department. Of course, the necessary information concerning causes of idleness could be secured without reference to the cost department, but the inclusion of cost figures not only gives the information attention value, but allows comparison with the cost of taking steps to remedy the conditions causing the idleness.

Fixed and variable costs. Variable costs, which change almost in proportion to the amount of business done, include direct wages, direct labor, and certain types of indirect expenses, such as the salaries of minor executives who are easily dropped in times of poor business, and income taxes, which vary almost directly with business done. Fixed costs remain constant almost irrespective of the amount of business which is done. These costs include not only the salaries of major executives, but interest on investment, particularly borrowed money, taxes on property, and obsolescence charges on both materials and equipment. Cost reports should clearly differentiate between these fixed and variable costs. Although the rendering of idleness expense reports will partially cover this field, nevertheless both the cost department and the interested executives must constantly have in mind this distinction between variable and fixed

costs. Any reports which clearly separate them will be of major assistance in the formulation of sales and production policies and in the formulation of administrative budgets.

Fixed costs must first be covered by receipts from sales in the computation of income during the determination of major policies. Thus, if fixed costs are $2000 per week, and sales are $5000 per week, there is left a balance of $3000 for the payment of variable costs and profits. Although variable costs vary with the volume of goods sold, yet for any given unit of goods, they remain practically constant. That is, for 50 units they would be practically double the amount that they would be for 25 units. In other words, they vary proportionately with the amount of goods produced. The variable cost per unit may be readily determined approximately. Assume that the $5000 of sales represents 50 units of product, the variable cost per unit of which is $60. This will give a variable cost of $3000 to be applied to the week's sales. Inasmuch as this is the exact amount remaining after deducting fixed costs from sales, it follows that the week's business was done practically at cost. If $7500 of business were done, there would remain $5500 to be applied to variable costs, which at $60 per unit would be only $4500 and $1000 would remain for profit. If $4000 of business were done, there would remain but $2000 to be applied to variable costs, which would be $2400, and there would be a loss of $400 on the week's business.

Although computations such as the foregoing can only be used as approximations by the management, yet they are valuable in the formulation of major business policies, and cost statistics should be prepared with a view to their use as indicated. In most businesses, the computations will not be quite so simple as the illustrations, inasmuch as fixed costs will not remain exactly fixed, and variable costs may not remain the same per unit of product. As production increases, the variable cost per unit will be likely to decrease somewhat. Possibly some variable costs will remain constant per unit of product and some will decrease slightly. In some cases, these variable costs of different types would have to be segregated in the cost reports. Tables can be prepared which will indicate the variable cost per unit at different points in the production scale, as well as modifications in fixed cost which are likely to occur as production changes. With these data to utilize, the general management will be in an excellent position to determine general sales and production policies, although the information thus obtained will not be exact enough for the accurate fixing of selling prices. Thus a consideration of fixed and variable cost is mainly useful as a guide-post for the formulation of major business policies.

Cost of production has frequently been the only figure shown by cost reports. Consideration of the paragraphs on idleness expense and those

on fixed and variable cost will quickly indicate that, for management purposes, reports on the cost of not producing are quite as important as reports on the cost of production.

The cost system and the budget. The administrative budget, which serves as the co-ordinating control over all operating departments, must necessarily be based on cost figures. This not only indicates the necessity of keeping the cost figures up to date, and having a system of collection which will allow costs to be kept up to the minute, but also indicates the extent to which management control is dependent on costs. In making the budget the cost records of past years give dependable information, but the current cost figures must be utilized in laying out the programme for the months to come. Cost records during a budget period can be carefully analyzed only in the light of the budget which was prepared as the target. The cost record becomes the progress report on obligations fulfilled by department heads, and permits modification of operating procedure or change of business plans during the course of a budget period. This again indicates the necessity of developing cost records so that they will be comparable with the organization of the business.

The new business era is one of competition, of profits through effectiveness of operation rather than through control of some major resource or important process. Although no particular phase of sound management will alone insure successful operation, nevertheless all operating decisions must in the end be based on cost results achieved through them. Thus, accurate reckoning of costs becomes the basis on which the expediency of management steps and decisions is determined. And costs must not only be reckoned accurately, but in ways which will permit their utilization for the formulation of management policies and the execution of management programmes.

BIBLIOGRAPHY

General

Babcock, G. D., Taylor System in Franklin Management, Engineering Magazine Co.

Bigelow, Carle M., Management in the Woodworking Industry, Engineering Magazine Co.

Brandeis, L. D., Business, a Profession, Small Maynard & Co.

Church, A. H., The Science and Practice of Management, Engineering Magazine Co.

Davenport, H. J., The Economics of Enterprise, The Macmillan Co.

Diemer, Hugo, Factory Organization and Administration, McGraw-Hill Book Co.

Drury, H. B., Scientific Management, Longmans, Green & Co.

Duncan, J. C., The Principles of Industrial Management, D. Appleton & Co.

Emerson, Harrington, Efficiency as a Basis for Operation and Wages, Engineering Magazine Co.

——, The Twelve Principles of Efficiency, Engineering Magazine Co.

Ennis, W. D., Works Management, McGraw-Hill Book Co.

Farnam, D. T., America vs. Europe in Industry, Ronald Press.

Faurote, F. L. and Arnold, H. C., Ford Methods and Ford Shops, Engineering Magazine Co.

Galloway, L., Office Management, Ronald Press.

Gilbreth, L. M., The Psychology of Management, Sturgis & Walton.

Going, C. B., Principles of Industrial Engineering, McGraw-Hill Book Co.

Hauer, D. J., Modern Management Applied to Construction, McGraw-Hill Book Co.

Jones, E. D., The Administration of Industrial Enterprises, Longmans, Green & Co.

Kent, R. T., Investigating an Industry, John Wiley & Sons, Inc.

Kimball, D. S., Principles of Industrial Organization, McGraw-Hill Book Co.

Marshall, L. C., Business Administration, The University of Chicago Press.

McVey, F. L., Modern Industrialism, D. Appleton & Co.

Parkhurst, F. A., Applied Methods of Scientific Management, John Wiley & Sons, Inc.

Porosky, Matthew, Practical Factory Administration, McGraw-Hill Book Co.

Redfield, W. C., The New Industrial Day, Century Co.

Shaw, A. W., Library of Factory Management, A. W. Shaw Co.

Tarbell, Ida, New Ideals in Business, The Macmillan Co.

Taylor, F. W., Principles of Scientific Management, Harper & Bros.
——, Shop Management, Harper & Bros.
——, On the Art of Cutting Metals, American Society of Mechanical Engineers.
Thompson, C. B., Scientific Management, Harvard University Press.
——, A Report on the Taylor System of Scientific Management, A. W. Shaw Co.
Waste in Industry, Federated Engineering Societies Report, McGraw–Hill Book Co.

Organization

Carpenter, G. U., Profit Making in Shop and Factory Management, Engineering Magazine Co.
Gowin, E. B., Developing Executive Ability, Ronald Press.
——, The Executive and his Control of Men, The Macmillan Co.
Mees, C. E. K., Organization of Industrial Scientific Research, McGraw–Hill Book Co.

The Factory Building

Day, Charles, Industrial Plants, Engineering Magazine Co.
Knowles, Morris, Industrial Housing, McGraw–Hill Book Co.
Price, G. M., The Modern Factory, John Wiley & Sons, Inc.

Job Study

Gilbreth, F. B., Fatigue Study, Sturgis & Walton.
——, Motion Study, D. Van Nostrand Co.
Lichtner, W. O., Time Study and Job Analysis, Ronald Press.
Merrick, D. V., Time Studies for Rate Setting, Engineering Magazine Co.
Vernon, H. M., Industrial Fatigue and Efficiency, E. P. Dutton & Co.

Wage Payment

Gantt, H. L., Work, Wages and Profits, Engineering Magazine Co.
Taylor, F. W., Shop Management, Harper & Bros.

Personnel Relations

Allen, C. R., The Foreman and His Job, J. B. Lippincott Co.
Bloomfield, Daniel, Labor Maintenance, Ronald Press.
Chapman, J. C., Trade Tests, Henry Holt & Co.
Commons, J. R., Industrial Government, The Macmillan Co.
Feis, Herbert, The Settlement of Wage Disputes, The Macmillan Co.
Fish, E. H., Employment Management, Engineering Magazine Co.
Hartness, J., Human Factors in Works Management, McGraw–Hill Book Co.
Hoxie, R. F., Scientific Management and Labor, D. Appleton & Co.
——, Trade Unionism in the United States, D. Appleton & Co.

Kelley, R. W., Training Industrial Workers, Ronald Press.
Morris, J. Van L., Employee Training, McGraw–Hill Book Co.
Shefferman, N. W., Employment Methods, Ronald Press.
Tead, O., and Metcalf, H. C., Personnel Administration, McGraw–Hill Book Co.

Control of Operations

Basset, W. P., and Heywood, J., Production Engineering and Cost Keeping, McGraw–Hill Book Co.
Brinton, W. C., Graphic Methods for Presenting Facts, Engineering Magazine Co.
Cartmell, Madison, Stores and Materials Control, Ronald Press.
Clark, Wallace, The Gantt Chart, Ronald Press.
Farquhar, H. H., Factory Storeskeeping, McGraw–Hill Book Co.
Frederick, J. G., Modern Sales Management, D. Appleton & Co.
Hoyt, C. W., Scientific Sales Management, George B. Woolson & Co.
Knoeppel, C. E., Graphic Production Control, Engineering Magazine Co.
McKinsey, J. O., Budgetary Control, Ronald Press.

Periodicals

Annals of the American Academy of Political and Social Science.
Bulletin of The Taylor Society.
Factory, A. W. Shaw Co.
Industrial Management, Engineering Magazine Co.
Management, A. B. Gould Co.
Management and Administration, Ronald Press.
Quarterly Journal of Economics.
System, A. W. Shaw Co.

Pamphlet Material

Publications of American Society of Mechanical Engineers.
Publications of National Industrial Conference Board.
Publications of Society of Industrial Engineers.
Publications of the United States Chamber of Commerce.
Publications of Simplified Practice Division, United States Dept. of Commerce

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